INVESTIGATION OF THE ASSASSINATION OF PRESIDENT JOHN F. KENNEDY

APPENDIX TO HEARINGS

BEFORE THE

SELECT COMMITTEE ON ASSASSINATIONS

OF THE

U.S. HOUSE OF REPRESENTATIVES

NINETY-FIFTH CONGRESS

SECOND SESSION

VOLUME VI

PHOTOGRAPHIC EVIDENCE

MARCH 1979

Printed for the use of the Select Committee on Assassinations

U.S. GOVERNMENT PRINTING OFFICE

42-370 O WASHINGTON : 1979

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402
Stock No. 052-070-04977-4

SELECT COMMITTEE ON ASSASSINATIONS

LOUIS STOKES, Ohio, *Chairman*

RICHARDSON PREYER, North Carolina
WALTER E. FAUNTROY, District of Columbia
YVONNE BRATHWAITE BURKE, California
CHRISTOPHER J. DODD, Connecticut
HAROLD E. FORD, Tennessee
FLOYD J. FITHIAN, Indiana
ROBERT W. EDGAR, Pennsylvania

SAMUEL L. DEVINE, Ohio
STEWART B. McKINNEY, Connecticut
CHARLES THONE Nebraska
HAROLD S. SAWYER, Michigan

Subcommittee on the Assassination of Martin Luther King, Jr.

WALTER E. FAUNTROY, *Chairman*
HAROLD E. FORD
FLOYD J. FITHIAN
ROBERT W. EDGAR
STEWART B. McKINNEY
LOUIS STOKES, ex officio
SAMUEL L. DEVINE, ex officio

Subcommittee on the Assassination of John F. Kennedy

RICHARDSON PREYER, *Chairman*
YVONNE BRATHWAITE BURKE
CHRISTOPHER J. DODD
CHARLES THONE
HAROLD S. SAWYER
LOUIS STOKES, ex officio
SAMUEL L. DEVINE, ex officio

STAFF

G. ROBERT BLAKEY, *Chief Counsel and Staff Director*
GARY T. CORNWELL, *Deputy Chief Counsel*

CONTENTS

*This section is not directly relevant to any conspiracy issue, but rather pertains to the question of an Oswald alibi. See sec. III-B.

REPORT OF THE PHOTOGRAPHIC EVIDENCE PANEL*

I. Introduction

(1)** The events in Dealey Plaza, Dallas, Tex., on November 22, 1963, surrounding and including the assassination of President John F. Kennedy, were recorded in a substantial body of photographic evidence. More than 510 photographs that relate directly to the assassination were taken by approximately 75 photographers, in addition to substantial other relevant photographic evidence pertaining to events that did not involve the actual assassination. *(1)*

(2) This photographic evidence provided the Warren Commission with a basis for attempting to resolve important issues such as the number, timing, and source of the shots fired at President Kennedy. The generally poor quality of portions of the materials, however, has resulted in many interpretative questions regarding matters that the Warren Commission purported to resolve. In the years since the Warren Commission, independent researchers have criticized its findings that were based upon photographic evidence as incomplete and unsubstantiated. *(2)*

(3) It is clear that the Warren Commission's investigation was limited for a number of reasons:

(4) 1. It did not have access to all critical photographic materials, such as those from the autopsy;

2. Potentially important photographs were not located;

3. The Commission did not have its own investigators and analysis, but had to rely on other Government agencies, thereby bringing the credibility of its report, if not the quality, into question; and

4. Photographic enhancement technology was not as sophisticated or effective in 1963–64 as it has since become.

(5) In contrast, the House Select Committee on Assassinations, because of the independent status established by its congressional mandate, was able to select its own panel of photographic experts who had access to files and photographic records that, for one reason or another, were not available to the Warren Commission. The committee was also able to secure access, and have its panel review, independent studies that had been conducted in the years since the Warren Commission.

(6) The sciences associated with photography have been advanced significantly in recent years. New processes in chemistry and radio chemistry and new films make possible great sensitivity to changes in the light and dark tones of an image and in the recording of small details. *(3)* Another important development has been the use of com-

---

*Materials submitted for this report by the photographic panel were compiled by HSCA staff members Michael Goldsmith and Jane Downey.

**Arabic numerals in parentheses at the beginning of paragraphs indicate the paragraph number for purposes of citation and referencing; italic numerals in parentheses in the middle or at the end of sentences indicate references which can be found at the end of this report.

puter technology for the enhancement of photographic picture quality. (*4*)

(7) Accordingly, the panel was ultimately expected to apply, within the given time and monetary constraints, the most sophisticated photographic technology available to resolve outstanding issues related to the photographic evidence. These issues included the number, timing, and source of the shots, the identification of the murder weapon(s), the identity of the assassin(s) and possible coconspirators, the authentication of both the Kennedy autopsy materials and several incriminating photographs of Oswald with the alleged murder weapon, and the validity of the "second Oswald" theory.

A. Selection of the Photographic Experts

(8) Early in 1978, after consulting officers and members of the American Society of Photographic Scientists and Engineers, the committee convened a panel of experts with varied backgrounds in the photographic sciences to study the available photographic evidence related to the assassination and to advise on the newest analytical and scientific procedures which could be effectively applied.* The panel included a broad range of technological expertise, covering such diverse areas as photographic image enhancement, photogrammetry, photointerpretation, and forensic photography.** The photographic evidence panel was composed of the following individuals:

Harry C. Andrews, Ph. D., Image Processing Institute, University of Southern California, Los Angeles, Calif.

Richard J. Blackwell, B.S., M.S., Jet Propulsion Laboratory, Pasadena, Calif.

Thomas N. Canning, B.S., M.S., National Aeronautics and Space Administration, Moffett Field, Calif.

Robert Chiralo, B.S., M.S., the Aerospace Corp., Los Angeles, Calif.

David B. Eisendrath, B.A., consultant in technical and scientific photography, Brooklyn, N.Y.

Ronald Francis, Ph. D., School of Photographic Sciences, Rochester Institute of Technology, Rochester, N.Y.

William K. Hartmann, B.S., M.S., Ph. D., senior scientist, Planetary Science Institute, Tucson, Ariz.

---

*Initially, an effort was made to limit membership on the photographic evidence panel to individuals who had never done any work for the U.S. intelligence community. Nevertheless, after spending weeks contacting various photographic specialists, it became apparent that most of the leading photographic scientists in this country have done some intelligence-related work. Accordingly, a previous affiliation with an intelligence agency was not considered to be an automatic basis for precluding someone from membership on the panel.

**Each of these terms has a particular meaning or technical trade usage among photographic scientists. The terms have been defined in the "Dictionary of Contemporary Photography" (L. Stroebel and H. N. Todd, Morgan & Morgan, Inc., publishers, Dobbs Ferry, N.Y. 1974):

Forensic photography—The specialization of making photographs for law enforcement or related purposes.

Image enhancement—Any process by which a photographic record is improved, as by increase in sharpness or contrast, or by reduction in noise.

Photogrammetry—The technology of using photographic methods to make accurate measurements. The term, initially applied to aerial surveying and cartography, et cetera, has been extended to include other types of mensuration, even to photographic methods of fitting garments to a person. Also see photometrology.

Photointerpretation—The process (usually visual) of obtaining qualitative or quantitative information from a photograph. The term initially had a military connotation but has been extended to other areas, such as geodetic, agricultural, climatic, and population studies.

Bob R. Hunt, B.S., M.S., Ph. D., professor, systems and industrial engineering and optical sciences, University of Arizona, Tucson, Ariz.

Donald H. Janney, Ph. D., Los Alamos Scientific Laboratory, University of California, Los Alamos, N. Mex.

Ellis Kerley, B.S., M.S., Ph. D., chairman, department of anthropology, University of Maryland, College Park, Md.

Sgt. Cecil W. Kirk, Mobile Crime Lab, District of Columbia, Metropolitan Police Department.

Charles J. Leontis, B.S., M.S., the Aerospace Corp., Los Angeles, Calif.

C. S. McCamy, B.C.E., M.S., vice president, science and technology, Macbeth Division, Kollmorgen Corp., Newburgh, N.Y.

Gerald M. McDonnel, M.D., department of radiology, The Hospital of the Good Samaritan, Los Angeles, Calif.

Everett Merritt, retired scientist in analytical photogrammetry, geodesy, and astrophysics, Ridge, Md.

Paul G. Roetling, B.A., Ph. D., principal scientist, image processing area, Xerox Corp., Rochester, N.Y.

Frank Scott, B.S., M.S., the Perkin-Elmer Corp., West Redding, Conn.

Robert H. Selzer, B.S., M.S., M.A., Jet Propulsion Laboratory, Los Angeles, Calif.

Bennett Sherman, B.S., M.S., consultant on optics and allied sciences, Elmhurst, N.Y.

Philip N. Slater, B.S., Ph. D., professor, optical sciences, University of Arizona, Tucson, Ariz.

Clyde C. Snow, B.S., M.S., Ph. D., Chief, Physical Anthropology Division, Civil Aeromedical Institute, Federal Aviation Administration, Oklahoma City, Okla.

George W. Stroke, B.S., Ph. D., former professor of medical biophysics and electrical sciences at Harvard University and State University of New York, Stony Brook, N.Y.

*B. Image Enhancement Technology**

(9) Three types of enhancement technology were available to the panel.

1. PHOTO-OPTICAL/PHOTOCHEMICAL ENHANCEMENT

(10) The recording of a photographic image involves the optical and chemical properties of halide salts of silver. Silver halides, such as silver bromide, silver chloride, or silver iodide, are sensitive to light. Light falling on small grains of these salts makes the silver compounds reactive to other compounds known as developers. During the film development process, a developer separates the silver atoms from the halide atoms (for example, bromine, chlorine, et cetera), which can be washed away by other compounds, leaving an image or picture made up of the remaining grains of silver.(*5*)

(11) Thus, every photographic image is recorded by microscopic silver grains. The presence of these grains is directly a function of light, since light is required to change the silver halide compound so that it may be acted upon by the developer. Where no light falls upon the film, little or no silver will be deposited by the process of development. Where much light falls on the film, much silver will be deposited. The relation between the amount of light and of silver grains results in the creation of a photographic negative or image. The image is referred to as a negative because the regions of the film with little silver appear light, while those with much silver appear dark, even though the regions respectively correspond to dark and bright portions of the object photographed.

(12) Color photography is a simple extension of the process involved in black and white photography. A color photograph has three separate layers of silver grain. Each is sensitive to only one particular

*This section prepared under the direction of Bob R. Hunt.

primary color of light, a property achieved by color filtering compounds intermixed with the layers of grain. One layer might respond only to red, a second to green, a third to blue. Since all secondary colors can be composed from a proper mixture of these three primary colors, the film can record any color of light. In the color development process, the silver grains are replaced by color dyes, and the primary colors of the layers combine to form the true image colors.

(13) The visual qualities of a photographic image are governed by the physical and chemical properties of the constituents in the photographic process, for example, the actual silver halide compound used, the size of the silver halide grains and the distribution (from smallest to largest) of the sizes of the grains, the chemicals used for development, and the time and temperature at which development is carried out. Once a developed photographic image has been produced, the image carried by the silver grains is fixed within the developed piece of film.

(14) Other photographic processes can be used to amplify differences in deposited silver that are faint in the original film. The extent to which an image feature can be visually detected is associated with contrast, which is related to the difference between the brightest and darkest portions of an image. (*6*) Features with low contrast, that is, with small differences between the maximum and minimum deposition of silver grains, are difficult (or impossible) to detect visually. However, if differences do exist, it is possible to use photographic materials and processes to enhance them.

(15) Photo-optical and photochemical enhancement may be used to improve image contrast. This type of enhancement employs high contrast photographic materials and processes, that is, materials and processes which amplify low-contrast details, making greater the differences between bright and dark portions of the image so that they become visible. The experienced photographer often refers to these techniques as "darkroom exercises," because an enhanced copy of the original image is produced in the darkroom by selection of photographic materials, exposure time, and development chemistry.

2. DIGITAL IMAGE PROCESSING

(16) Digital image processing is the use of a digital computer to manipulate an image. When successful, this process may be used to clarify images by removing blur and altering contrast. The actual type of computer manipulation chosen depends on what is to be achieved. For example, computer enhancement of image detail requires a different computer process than that for measuring object dimensions.

(17) There are three important phases in computer image processing: (1) Image sampling and quantization; (2) computer processing of the image samples; and (3) re-creation of an image from the computer's output. (*7*)

(18) Sampling and quantization is the process of converting an image into computer numbers. An image is a representation of visible light, whereas a computer works with numbers. The visible light representation of an image must be converted into numbers of the kind used by the computer. This is done by a device generically referred to as a sampler/quantizer; as applied in this process, it is known as a scanning microdensitometer.

Simple Diagram of Computer Scan of Image

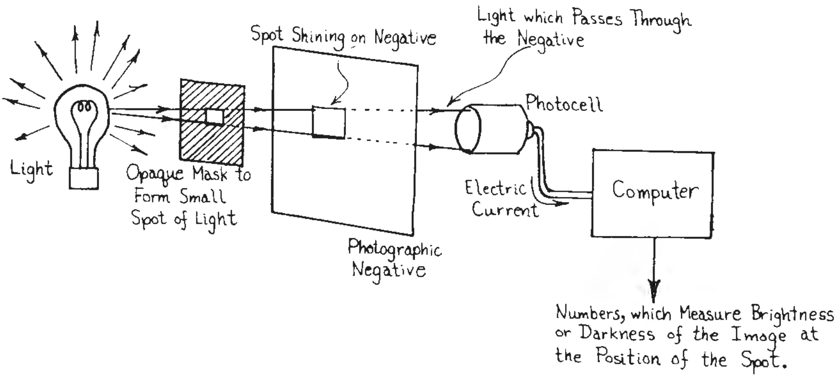


FIGURE I–1

(19) Figure I–1 (JFK exhibit F–149) is a schematic diagram of the sampling/quantization process. A small spot of light is projected onto a photographic transparency image. Light passes through the image at the position of the spot and is collected by a photocell. The amount of light collected is directly proportional to how dark or light the transparency is at that position. The collected light causes an electric current to flow; its strength is directly proportional to the strength of the light which passes through the image. The electric current is measured by the computer, which breaks the current into a discrete number of intervals and assigns a number, or value, for the amount of current in each interval.

(20) For example, the computer might divide an electric current, ranging from zero to a maximum of "I" amps,* into 1,000 intervals. If the current, when measured, falls into the 350th interval between zero and "I" amps, then the computer would assign the number "350" to that image brightness. By moving the light spot over the entire image, it is possible to extract all the important information. The actual number of samples which must be extracted is governed by a specific mathematical relation which depends on the content of the image. (*8*)

(21) The colloquial interpretation of sampling implies a partial

*Amps is the conventional abbreviation for amperes, the international standard for measurement of electric current. By convention, "I" symbolizes an unspecified amount of electric current.

extraction of information. Nevertheless, engineering usage of the term implies extraction of all relevant information; mathematical theorems prove that proper sampling does, in fact, extract all relevant information. In the context of digital image processing, the term sample refers to the size of the image area that is scanned by the microdensitometer. Thus, if there is a lot of information content (that is, in terms of small detail and fine structure), the samples (that is, areas scanned on the film) must be closely spaced and a large number will be required; if there is not a lot of information content, the samples need not be as closely spaced and a smaller number will be needed. Given typical processing conditions and common camera and film combinations, a matrix of samples ranging in size from 100 by 100 to as many as 1,000 by 1,000 samples or even more will be extracted.

(22) Color images can be sampled and quantized in the same way. The sampling must, however, be repeated three times; each repetition is carried out with a colored filter in the optical path of the microdensitometer. The proper choice of filters (for example, red, green, blue) leads to measurements of relative color strengths which make it possible to recreate any arbitrary color in the image.

(23) After sampling and quantization, the numbers that represent the image are run through a computer. A specific computer operation is selected on the basis of a mathematical model. The physical processes that took place in the creation of the photographic image can be described by mathematical equations. Even processes that resulted in an undesirable degradation of image quality can be described by such models. The numbers measured in the sampling and quantization process represent actual numerical values of the mathematical variables of the model.* The computer is used to solve the equations of the mathematical model, and the solution of the equations will be the numerical representation of an image that has been enhanced in some fashion. The actual type of enhancement will depend, of course, on the particular mathematical model used. (*9*)

(24) The third and final phase is to recreate an image from the numbers representing the enhanced image. There are two basic methods for recreating an image: hard copy and soft copy.

(25) Hard-copy image display can be exemplified by a system similar to the schematic diagram shown in figure I-1 (JFK exhibit F-149). The spot of light, its brightness converted by the computer according to the value of numbers corresponding to each image spot, is run over a piece of unexposed photographic film. When the film is developed, an image emerges, composed of all the small individual spot exposures. This method is known as hard copy because it produces a tangible item, the piece of developed film.

(26) In soft-copy display, the numbers in the computer are transmitted into a special computer memory, that can be used to position a spot of light on the face of a television display tube. The actual position of the light spot and its brightness will depend both on the particular computer memory location and the number occupying that location. By rapidly and repeatedly reading the numbers from the memory and writing light spots on the TV display, a display of the image is

---

*A mathematician would say that the measured image's numerical values are "substituted" into the equations of the model.

created. It is similar to the image on a home television set, but is of far superior image quality to any home television display.

(27) Computer displays are referred to as soft copy because the image is transient on the face of the television display rather than a permanent thing. Computer soft-copy displays have a distinct advantage over hard-copy displays. The image is created from the contents of the computer's special memory, that can be altered by the computer. Any such change in the image is instantly visible on the screen. The image analyst can use this instant display of results to interact directly with the computer to produce mathematically an enhanced image with the most desirable visual qualities. Each of the three digital image processing facilities employed by the committee possessed interactive soft-copy display equipment, which played an important role in the creation of enhanced imagery for the Panel.

(28) It is important to understand the differences in effect between hard-copy and soft-copy methods of image display. Hard-copy displays are not as effective because they may suffer from degradation. A soft-copy display can produce a more brilliant image with a wider dynamic range than can a hard-copy display, i.e., the difference between darkest and brightest regions of the image will be greater. If color imagery is involved, the fidelity of color representation is more accurate in a soft-copy display. Unfortunately, the permanent visual results of an image enhancement process can be recorded only on a hard-copy display.* The quality of hard-copy displays reproduced in this report may be less than that of the soft-copy displays used by the Panel and contractors in their analysis and deliberations; the final conclusions of the Panel, however, were based on the best possible image displays, and not on the displays reproduced in this report.

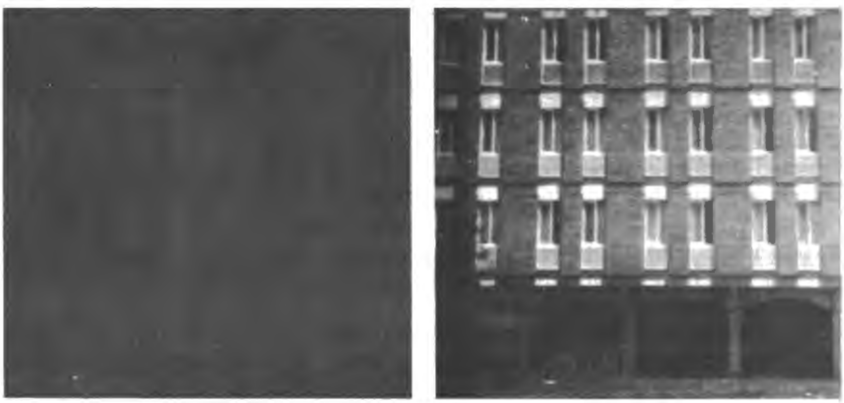


FIGURE I-2.—Computer Contrast Enhancement.

(29) Figure I-2 (JFK exhibit F-150) shows the type of image enhancement that may be achieved by an interactive soft-copy display. The original image, shown on the left, is of extremely low contrast, that is, the maximum and minimum brightnesses of the image are

*The computer tape storing the numerical values that have been assigned to the image samples can also be permanently retained, but this, of course, is not an actual visual record.

virtually the same; little detail is visible. Using an interactive display, the range of contrast was greatly expanded to produce the enhanced image shown at the right of the exhibit. The result is a dramatic improvement. (The "contrast" control on a home television receiver expands contrast in a similar way; however, a computer-controlled contrast expansion has much more flexibility than does a television receiver.)

Figure I–3.—Successful Image Deblurring.

(30) Figure I–3 (JFK exhibit F–151) shows the different kind of enhancement that may be achieved with digital image processing. The photograph at the left was taken by a camera that was moved while the shutter was open. The sign is badly blurred, and most of its fine detail has been lost. The objective in enhancing this image is to minimize the effects of the blur.

(31) Removing an image blur after the picture is recorded on film is a process that has been extensively studied in recent years. The basic principle can be summarized as follows. The blurred image that is recorded on film can be represented by an image formation equation as being the result of an ideal (or unblurred) image that has been degraded by blur. (*10*) If the image formation equation can be solved for the ideal or unblurred image, then an image is produced which has had the blur removed. Solving the image equation requires the solution of hundreds of thousands (sometimes millions) of algebraic equations. The magnitude of this process made it impossible to carry out until the introductioin of new computing algorithms in the 1960's and the availability of large scientific computers.

(32) The image at the right in figure I–3 (JFK exhibit 151) shows the result of deblurring by this process. The increased legibility of fine detail and letters is dramatic when compared with the original.

(33) The process of image deblurring can be so dramatic that it is frequently misinterpreted as a magical "cure-all." There are fundamental limitations, however, on the extent to which a blur can be removed. These limitations are due to what is called "noise." Anyone who has lived in a "fringe-area" for television reception has seen noise in an image: the speckled or "salt-and-pepper" graininess visible in a weak television image (colloquially referred to as "snow") is the

result of random fluctuations in the weak electronic TV signal. Noise represents random uncertainties in the values of the image and is not attribntable to any particular cause.

(34) Since these image values are used to solve the equations to produce a deblurred image, uncertainties or inaccuracies in these values lead to errors or inaccuracies in the solution. The more noise present in a blurred image, the more unsuitable a deblurred image will be. Figure I-4 (JFK exhibit F-152) illustrates this situation.

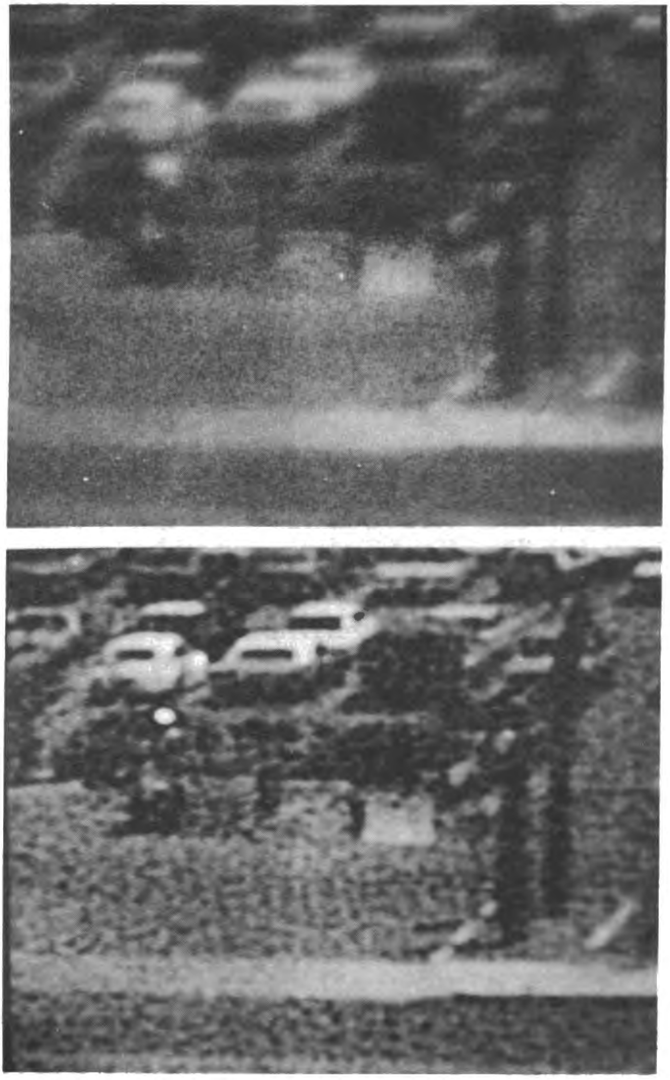


FIGURE I-4. Unsuccessful Image Deblurring

The original image on top is blurred and very noisy. The deblurred image on the bottom shows virtually no improvement in image quality due to the limitations imposed by noise.

3. AUTORADIOGRAPHIC ENHANCEMENT

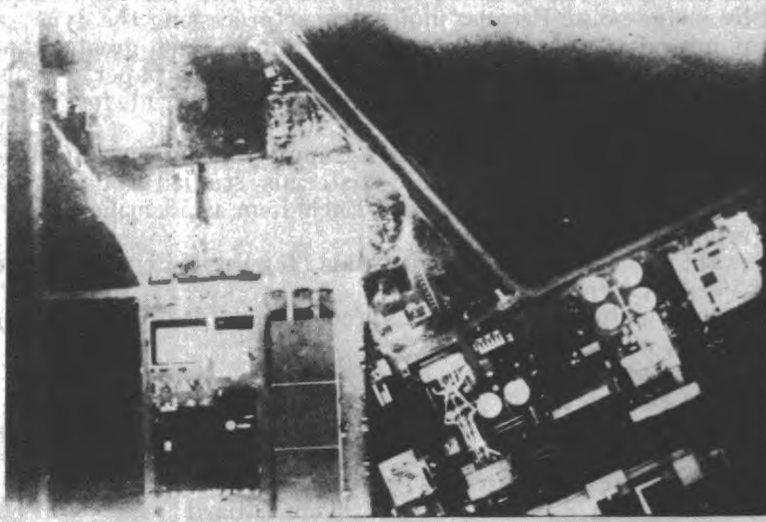
(35) Autoradiographic enhancement involves the use of a radioactive chemical to achieve enhancement of image contrast rather than the removal of image blur. (*11*) Autoradiographic enhancement is applicable only to black and white films.

(36) As noted earlier, a photographic image is created by the deposition of minute silver grains. A minimum number of grains must be deposited for the image to be visible. Any weak light falling on a piece of film will cause some deposition of silver grains, but the number may be too small for interpretation. Autoradiographic enhancement tries to strengthen this weak image.

(37) This is attempted by bathing the film containing the weak image in a radioactive chemical that binds to silver, thereby making every silver grain a source of radioactivity. The radioactive film is placed in contact with a piece of X-ray film, which is exposed by the radioactive silver grains. The longer the X-ray and radioactive films are in contact, the greater the radioactive exposure of the X-ray film. When the X-ray film is developed, even very small numbers of silver grains in underexposed areas of a film will be made visible.

SRI INTERNATIONAL AUTORADIOGRAPHIC ENHANCEMENT OF PHOTOGRAPHIC IMAGES

(a) AERIAL PHOTOGRAPH, UNDEREXPOSED BY A FACTOR OF 12



(b) AUTORADIOGRAPHIC INTENSIFICATION OF AERIAL SCENE SHOWN IN (a)

Type R x-ray film, 48-hr exposure.

MP-319583-53A

(38) Figure I–5 (JFK exhibit F–154) illustrates the application of the autoradiographic enhancement procedure. The original image is severely underexposed; there was only one-twelfth as much light as was needed to expose the negative properly. The enhanced image is the result of the autoradiographic technique.

C. Source Materials for Enhancement

(39) Image enhancement can result in dramatic photographic clarification, but the extent of improvement is limited by the quality of the original images. That is, an image may be so severely degraded that no combination of enhancement techniques can improve it. One parameter already mentioned that limits enhancement is image noise.

(40) Any photographic copying process will introduce some noise into a copy. In most cases, this new noise will not be detrimental. Moreover, in general, there are so many other potential difficulties in image copying such as loss of sharpness and resolution, loss of contrast, and loss of gray tones that it is undesirable to attempt to enhance these copies. The Panel made a decision to work only with original images for enhancement.

(41) The Panel also adopted a policy of working with transparency images as much as possible as distinct from prints that are on an opaque base. An important property of any image is the dynamic range of values of brightness from smallest to largest. Given a certain level of photographic noise, an image with a wide dynamic range is preferable to one with a narrow dynamic range because the accuracy of brightness representation increases as the dynamic range increases. In effect, the wider the dynamic range, the less interference is occasioned by image noise. Because under proper processing the dynamic range of images recorded on transparency film is much greater than with opaque film (for example, photographic print paper), transparency film images are preferable as source material for image enhancement.

(42) Following is a list of the most important original (unless otherwise indicated) photographic materials studied for possible enhancement and analysis purposes. Each item is identified by its photographer's name:

1. Oswald "backyard picture" materials (for list of items, see paragraphs 366–370, *infra.*)
2. Kennedy autopsy photographs (color and black and white), transparencies and X-rays.
3. Color photographs:
   - Wilma Bond
   - *Robert Croft
   - James Powell
   - Jim Towner
   - Phillip Willis
4. Black and white photographs:
   - William Allen
   - James Altgens
   - *Jack Beers
   - *Hugh Betzner
   - Richard Bothun
   - *Tom Cablack
   - *Frank Cancellare
   - *Malcolm Couch (movie stills)
   - Tom Dillard
   - *Joe Laird
   - Mary Moorman
   - *Jim Murray
   - Arthur Rickerby
   - *George Smith
   - *George Weaver
   - *David Weigman (movie stills)

5. Motion picture films:
   *Thomas Alyea
   Mark Bell

Dallas Cinema Associates combined sequences taken by 18 photographers, including John Martin and Charles Mentensana; for others see H. Weisberg, *Photographic Whitewash: Suppressed Kennedy Assassination Pictures* (published by author, 1967), p. 254.

Elsie Dorman
Robert Hughes
Marie Muchmore
Orville Nix
*Patsy Paschell
Tina Towner (Barnes)
Abraham Zapruder

NOTE: Initially, Robert Groden, a photographic consultant to the committee advised the panel as to pertinent photographic issues and related materials. Committee investigators located many of the suggested films and photographs, however, some items were never located, i.e. the Babushka Lady film, a color photograph by Norman Similas, and the original negative of the Betzner photograph.

D. Panel Procedures

(43) The Photographic Evidence Panel was responsible for establishing the guidelines and procedures under which all of the committee's photographic enhancement and analytic work was to be accomplished. Because of the large quantity of material to be examined, it contracted with several laboratories to perform, under its general direction, all necessary photographic enhancement work and, on occasion, some analytic work as well.

(44) Photo-optical/photo-chemical enhancement was undertaken by a team of professors at the Rochester Institute of Technology, and digital image processing was performed by the University of Southern California Image Processing Institute, the University of California Los Alamos Scientific Laboratory and The Aerospace Corp. Once these contractors had completed their work, the results were submitted to the Panel for interpretation and its own independent analysis.

(45) The Photographic Evidence Panel first met with the committee and representatives of the laboratories in February 1978. At that time, the Panel was apprised of the issues that the photographic evidence touched upon, and assigned the overall task of examining the photographic material compiled by the committee.

(46) After the Panel had reviewed these materials, enhancement and analytic projects were outlined and assigned to the laboratories. Analytic studies were also assigned to individuals and groups within the Panel, according to their respective specialties. The work was conducted with periodic reviews by the Panel, between February and mid-July, when the Panel held its final conference to evaluate all the results.

---

*Copy prints.

II. The Number, Timing, and Source of the Shots Fired at the Presidential Limousine

A. *Warren Commission Findings*

(47) The Warren Commission concluded that three bullets had been fired at the Presidential limousine from the sixth floor, southeast corner window, of the Texas School Book Depository. Finding that the first pierced the President's neck, the Commission also indicated that "[a]lthough * * * not necessary to any essential findings * * *, there is very persuasive evidence from the experts to indicate that [this] * * * same bullet * * * also caused Governor Connally's wounds." (*12*) A second bullet caused a massive and fatal wound to the President's head; (*13*) a third bullet was believed to have missed the car and its occupants. (*14*)

(48) The Commission was unable to establish conclusively which of the three bullets missed, and hence the precise timespan of the shots was not definitively determined. By studying the Zapruder movie film, it found that the President's back wound occurred between frames 210 and 225, and that the head wound occurred at frame 313. (*15*) Based upon the 18.3 frame-per-second average rate of speed at which film was exposed in Zapruder's camera, the Commission then calculated that "there was an interval of from 4.8 to 5.6 seconds" between those two shots. (*16*) If the second bullet were the one that missed, then this interval was the timespan for all the shots. If, however, either the first or third bullet missed, the minimum timespan would have been 7.1 to 7.9 seconds (derived from the previous calculation of 4.8 to 5.6 seconds plus 2.3 seconds, the minimum time in which Oswald's Mannlicher-Carcano rifle could be fired). (*17*)

(49) To support its conclusion that the President's and Governor's wounds were caused by shots that were fired from the sixth floor, southeast corner window, of the Texas School Book Depository, the Warren Commission relied on an FBI reenactment. Using the Zapruder film as the point of reference, the FBI placed the limousine and its occupants in their approximate positions at the time of the shots and then determined the angle from the wound entry point on President Kennedy to "the end of the muzzle of the rifle positioned where it was believed to have been held by the assassin." (*18*) The average resulting angle of 17°43′30″, allowing for a downward street grade of 3°9′, was concluded by the Commission to be "consistent with the trajectory of a bullet passing through the President's neck and then striking Governor Connally's back * * *." (*19*)

(50) Although each of these findings has been criticized, the Commission's statement that the bullet which caused President Kennedy's neck injury was also responsible for Governor Connally's wounds has caused the most controversy. Warren Commission critics have asserted that in the Zapruder film, Governor Connally first reacts to his wounds at frames 234 or 238, 0.5 to 1.5 seconds after the President (who the

Commission found was struck between frames 210–225) and, therefore, could not have been hit by the same bullet. Moreover, given the 2.3-second minimum firing time for a Mannlicher-Carcano rifle, they assert that another gunman must have been involved in the assassination.(*20*)

(51) Critics have also questioned the Commission's "single bullet theory" because they find that, given the wounds, the relative alinement of the President and the Governor within the limousine was inconsistent with the path of a single bullet.(*21*) They claim that the Commission's trajectory analysis was self-serving, since it assumed a particular location for the gunman and then merely sought to verify that the angle from rifle muzzle to the limousine occupants was consistent with the trajectory of a bullet passing through the two men.

B. The Panel's Analysis

1. APPROACH

(52) In an effort to determine the number, timing, and source of the shots that were fired at the Presidential limousine, the Photographic Evidence Panel conducted the following studies:

(53) (a) The Zapruder film was studied for evidence of reactions to gunshots by both the limousine occupants and Dealey Plaza witnesses, and to determine whether the relative alinement of John F. Kennedy and John B. Connally within the limousine was consistent with the single-bullet theory. Still photographs pertinent to the single-bullet theory controversy were also reviewed;

(54) (b) The blurs in the Zapruder film were analyzed to determine if they could be attributed with precision to the cameraman's reflex reaction to the sound of gunshots;

(55) (c) A trajectory analysis was conducted under the direction of an aerodynamics engineer from NASA; and

(56) (d) Photographs of the Dealey Plaza environs in which it has been alleged that gunmen can be seen were subjected to photographic enhancement and analysis.*

2. VISUAL EVIDENCE DERIVED FROM OBSERVATIONS OF PERSONS IN THE ZAPRUDER FILM**

(*a*) *Issues*

(57) The Panel was requested by the committee to address, at a minimum, three questions:

(58) (a) When did Kennedy first show a reaction to some severe external stimulus?

(59) (b) When did Connally first show a reaction to some severe external stimulus?

(60) (c) Was the relative alinement of Kennedy and Connally within the limousine consistent with the single-bullet theory?

---

*The results of this study are discussed at ¶241–346, *infra*.

** This section prepared under the direction of C. S. McCamy, Frank Scott and Bennett Sherman. For the related public hearing testimony of C. S. McCamy, 9/12/78, see HSCA–JFK Hearings, vol. II, pp. 142–54, 349–72.

(*b*) *Materials and procedures*

(61) The Zapruder film was studied with care at each of the panel's conferences.[1] At the final conference, which took place in July 1978, the film was closely scrutinized by more than 20 photographic scientists who were either members of the Panel or contractors responsible for much of the committee's laboratory work (i.e., photographic enhancement, restoration, etc.). At the Panel's request, a specially enhanced version of the Zapruder film had been obtained which stabilized and enlarged the images of Kennedy and Connally. The Panel was also given access to four frames which showed the Presidential limousine going behind a sign; these had previously been spliced out of the original Zapruder film. (*22*) Finally, computer assisted enhancements of relevant frames from the Zapruder film were made available to Panel members, but these were not reviewed until later.
(62) In total, the Zapruder film was viewed by this group on a frame-by-frame basis and at various speeds approximately 100 times.[2] A special analytical projector was used to facilitate this task. Because the quality of most of this film generally precluded analysis of facial expressions, primary emphasis was given to attempting to detect gross changes in body movements. As each frame was analyzed, proper consideration was given to the Zapruder film's exposure rate through the camera of 18.3 frames per second. (*23*) In this manner, changes in body movements between frames could be better understood and, at times, even quantified.
(63) After completing its review of the film the Panel took a vote with regard to each of the issues that had been raised by the committee.[3] The Panel's vote focused on those reactions to severe external stimuli that may have been suggestive of impacting bullets.

(*c*) *Conclusions*

(64) (a) By a vote of 12 to 5, the Panel determined that President Kennedy first showed a reaction to some severe external stimulus by Zapruder frame 207, as he is seen going behind a street sign that obstructed Zapruder's view.
(65) (b) By a vote of 11 to 3, the Panel determined that Governor Connally first showed a reaction to some severe external stimulus by Zapruder frame 224, virtually immediately after he is seen emerging from behind the sign that obstructed Zapruder's view.
(66) (c) By a vote of 15 to 1, the Panel determined that the relative alinement of President Kennedy and Governor Connally in the limousine was consistent with the single bullet theory.
(67) (d) At least two shots, spaced approximately 6 seconds apart, were fired at the Presidential limousine. Nevertheless, based only on

---

[1] For references to Zapruder frames discussed herein, see JFK exhibits F-209–274, HSCA-JFK Hearings, vol. I, pp. 69–97.

[2] It is difficult to state this figure with precision because various segments of the film were continuously replayed while others received considerably less attention.

[3] Because the film was not viewed simultaneously by all participants, some of whom occasionally had to leave the room to perform other tasks, and as the voting was conducted at different times for each issue, the same number of votes was not cast on each issue.

its review of the reactions of persons shown in the Zapruder film, there was insufficient evidence to reach any conclusion concerning additional shots.

(d) Analysis

(68) The first reaction by any of the limousine occupants to a severe external stimulus begins to occur in the vicinity of Zapruder frames 162–167.* At this time, Connally is looking to his left, when his head begins a rapid, sudden motion to the right. In quantitative terms, he turns his head approximately 60° to his right in one-ninth of a second (a rate equivalent to a 540° rotation per second). He pauses momentarily and then executes a further 30° turn to his right, within an eighteenth of a second (again, a rate equivalent to a 540° rotation per second). This initial rapid motion, in which Connally has apparently turned his head to look behind him, is accompanied during the next approximately 20 frames by a more gradual 60° shift to the right of his upper torso. Although it is apparent that none of the limousine occupants has been shot at the time that Connally initiates this movement, the Panel considers these actions to be particularly significant because they were consistent with his Warren Commission testimony that he turned in response to having heard the first shot and was struck almost immediately afterwards. (*24*)

(69) During the period of Connally's initial rapid movement, however, no one else shows a comparable reaction. The President does not appear to react to anything unusual prior to Zapruder frame 190. The Panel observed, however, that at approximately this time, a young girl who had been running across the grass, beyond the far curb of the street where the limousine was traveling, suddenly began to stop and turn sharply to her right, looking up the street in a direction behind the limousine.

(70) At approximately Zapruder frame 200, Kennedy's movements suddenly freeze; his right hand abruptly stops in the midst of a waving motion and his head moves rapidly from right to his left in the direction of his wife. Based on these movements, it appears that by the time the President goes behind the sign at frame 207 he is evidencing some kind of reaction to a severe external stimulus. By the time he emerges from behind the sign at Zapruder frame 225, the President makes a clutching motion with his hands toward his neck, indicating clearly that he has been shot.

(71) Connally's movements as he emerges from behind the sign at Zapruder frames 222–224 also indicate that he is reacting to a severe external stimulus. He appears to be frowning, and there is a distinct stiffening of his shoulders and upper trunk. Then there is a radical change in his facial expression, and rapid changes begin to occur in the orientation of his head.

(72) In the subsequent frames, Kennedy and Connally appear to show simultaneous, reaction-type movements. There is less than a three-frame (0.16 second) delay in their movements.

(73) At frame 313, approximately 6 seconds (based on the 18.3 frames per second exposure rate of the Zapruder camera) after the

---

***Because this reaction was not perceived as a response to an impacting bullet, it was not adopted as one of the panel's conclusions.**

President disappears behind the sign, his head is seen exploding from the impact of a bullet.

(74) Having noted the virtually simultaneous reactions displayed by Kennedy and Connally, the Panel proceeded to consider whether the two men's relative alinement in the limousine was consistent with the single-bullet theory. In this regard, the President is observed, between frames 170–190, to be sitting well to the right side of the limousine. Specifically, his right arm is extended over the chrome strip that runs along the side of the limousine. Governor Connally's rightward body orientation is clearly seen during these same frames. His body is situated much more toward the center of the limousine, as demonstrated by the amount of the rear seat that can be seen between President Kennedy and Governor Connally.

(75) This visual analysis was confirmed stereoscopically when computer enhancements of Zapruder frames 187 and 193 were examined in three dimensions as a stereo pair. Pairs of photographs, taken moments apart, may on occasion be viewed in a manner that gives rise to a three-dimensional image. When this occurs, the photographs are said to constitute a stereo pair.

(76) Stereoscopy may be explained as follows: Because human eyes are a short distance apart, each sees a slightly different aspect of any object within a distance of about 50 feet. These slightly different visual images are interpreted by the brain as clues to the relative distances of various parts of the object. This is called "stereopsis" or "stereoscopic vision." The two eyes see a single near object alined with different distant objects. This is known as parallax. This effect also contributes to the perception of depth.

(77) If two photographs are taken of the same nearby still scene and the camera is moved horizontally about 3 inches between the two exposures, the camera will record what would have been seen by two eyes (spaced about 3 inches apart), had they been in the same two places as the camera had been. When these photographs are viewed separately (so that one eye sees one photograph and another eye sees the other) by means of an optical device called a "stereoscope" or "stereo viewer," the visual system and the brain interpret the scene in depth, just as though the original scene were being viewed directly.

(78) The identical effect can be achieved with individual frames of a motion picture film such as the one taken by Zapruder. A motion picture film consists of a series of still photographs. A slight movement of the camera (that is, by about 3 inches) can result in individual frames being viewed as stereo pairs. In addition, even if the camera is held relatively still, a similarly slight movement by the object may give rise to stereo pairs of photographs. This is because, in relative terms, the effect is that of the camera moving in relation to a still object.

(79) When this technique was applied to the Zapruder film, the relative depth of Kennedy and Connally within the limousine could be carefully examined. On this basis, their relative alinement was found to be consistent with the single-bullet theory.

(80) The panel's conclusion of the relative alinement of the two men received further corroboration by an examination of still photographs and individual Zapruder frames.* It is further supported by the trajectory analysis described in the following section.

*In this regard, the Panel adopts the analysis set forth in ¶ 158–165 *infra*.

3. THE PANNING ERROR—BLUR ANALYSIS OF THE ZAPRUDER FILM*

(a) *Issues*

(81) (a) Can any of the panning errors indicated as blurs or "jiggles" on the Zapruder film reasonably be attributed to the photographer's involuntary startle reaction to the sound of gunshots?
(82) (b) If so, is it possible to determine from such panning error blurs the number, and to estimate the timing, of the shots that were fired at the Presidential limousine?

(b) *Procedures and materials employed*

(83) Originally, a blur study of the Zapruder film was to involve an analysis of not only the Zapruder, but also the Nix and Muchmore films, to determine whether startle reactions by the photographers were present and simultaneous for each photographer. Nevertheless, neither the Nix nor Muchmore films included any extensive footage prior to the time of the head shot. Thus, only the Zapruder film, which showed the entire motorcade scene immediately prior to and during the assassination, was subjected to this analysis.**
(84) The measurement of blur, or jiggle, essentially involved a measure of Zapruder's error in panning his camera as he filmed the Presidential limousine. Two sets of measurements were made independently by Photographic Evidence Panel members William Hartmann and Frank Scott. Hartmann measured the length of images of small highlights on the Presidential car in each frame; these were generally small and round on the sharpest frame but highly elongated on frames that were blurred by camera motion during the time that the shutter was open. The amount of elongation was measured to determine the panning error. (See fig. II–1.)

---

*This section prepared under the direction of William K. Hartmann. For Dr. Hartmann's related public hearing testimony, 9/11/78, see HSCA–JFK Hearings, vol. II, pp. 4–16.

**In addition, the Nix and Muchmore films were taken from a distance of about 2.7 and 2.1 times, respectively, further away from President Kennedy than the Zapruder film.

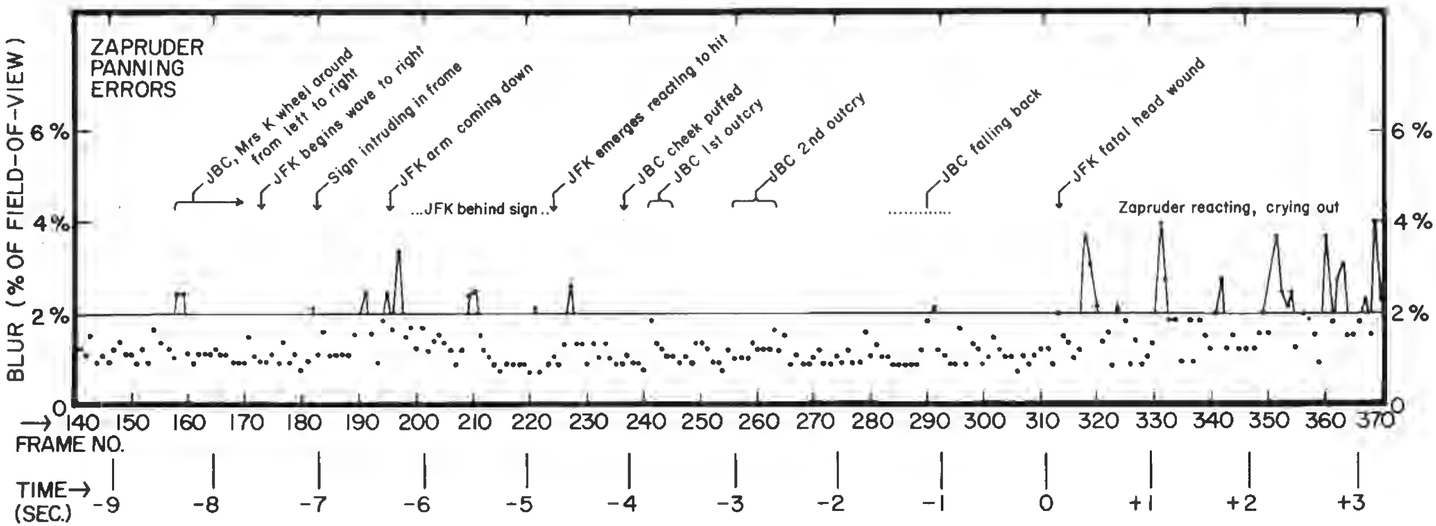


FIGURE II-1.—Amount of blur on each frame of Zapruder film as measured by W. K. Hartmann. Blur (elongation of images) is presented in terms of percentage of width of a whole frame. Large blurs represent jerking of camera, suggesting a startle reaction.

(85) Scott followed background details from frame to frame. These details indicated a direction in which the camera pointed during each frame. The sequence of these camera point directions would have defined a smooth, relatively straight line had the camera panned in a perfectly uniform manner (see fig. II–2, JFK exhibit F–371); discrepancies were revealed by erratic spacing of camera pointing directions (see fig. II–3, JFK exhibits F–372–373).

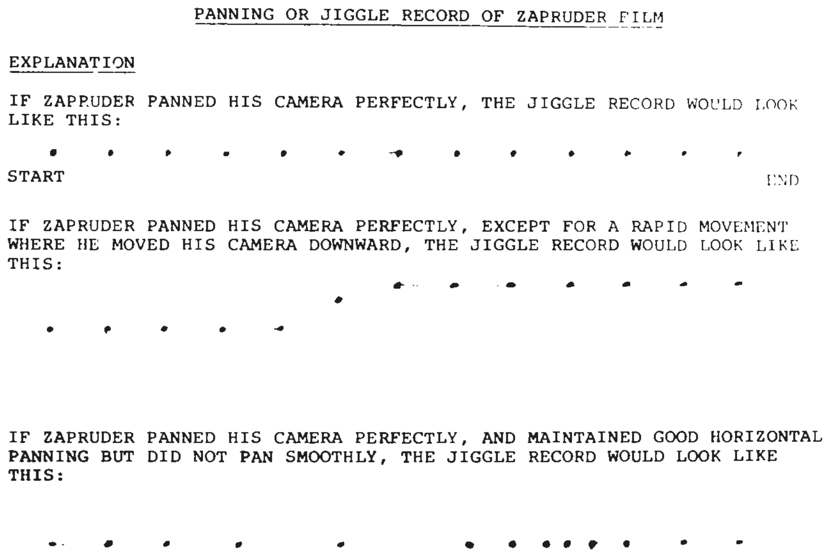


FIGURE II–2.—Illustration of technique used by Frank Scott. If Zapruder had made no panning errors, the background points from frame to frame would have been plotted as illustrated.

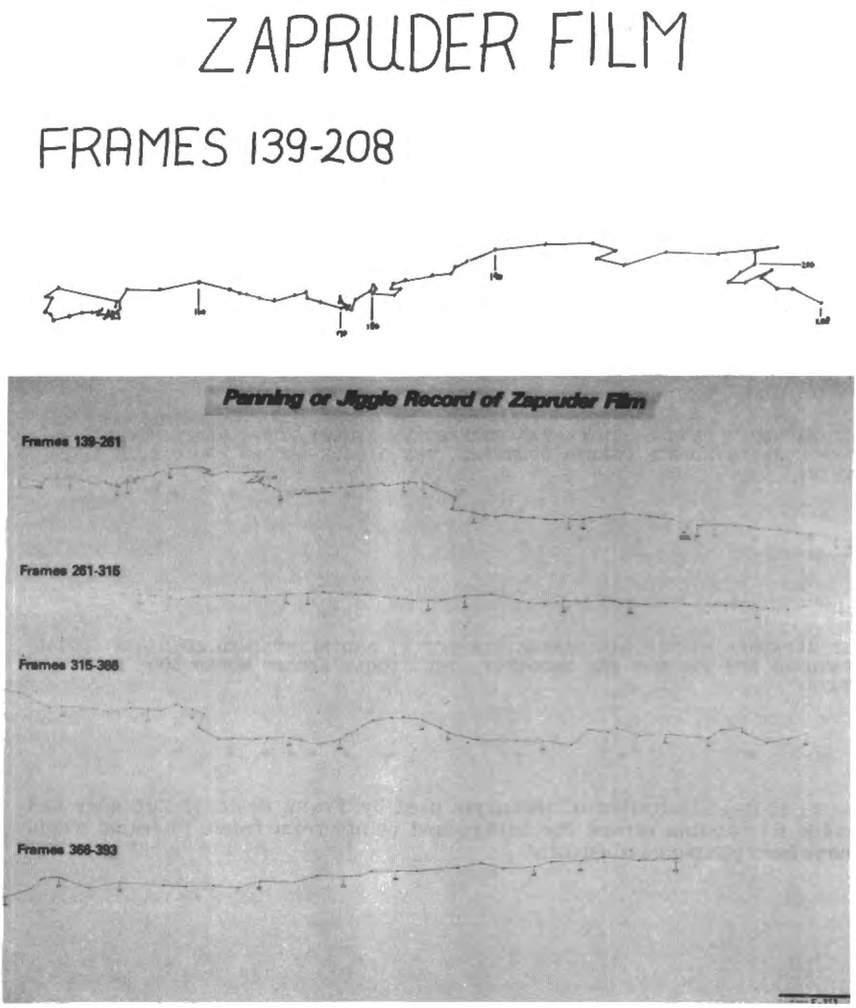


FIGURE II–3.—Actual plotting of background points from frame to frame by Frank Scott, showing Zapruder panning errors. Illustration on top, showing only frames 139–208, is enlargement of portion of illustration on bottom.

These were transformed into quantitative measurements by a vector subtraction process: A 20-frame running average of the rate of angular motion was used to predict the point where the camera should be aimed in frame *n*, based on the place where it was directed in frame *n–1*. A subtraction was then made between the *n–1* to *n* vector which should have appeared and the vector that actually did appear. This vector difference was then measured to determine the panning error between frames.

(86) The results of these measurements were then plotted to illustrate visually the times of greatest panning error in a manner similar to Figure II–1. (See fig. II–4.) In both Figure II–1 and Figure II–4, a threshold line was then drawn horizontally across the graph to separate visually the areas of greatest (i.e., unusual) blur from the "noise", or the normal panning errors that occurred throughout the filming simply because the camera was hand held. Any such threshold line, of course, must to some extent be arbitrarily placed. The extent of blur that resulted from an unusual external stimulus (e.g., a gunshot) may not, therefore, always be precisely delineated by the line. Zapruder's true startle reactions may have begun a frame or two earlier, or later, than indicated by the placement of the threshold line that was chosen, but blurs above the threshold line are well above the average.

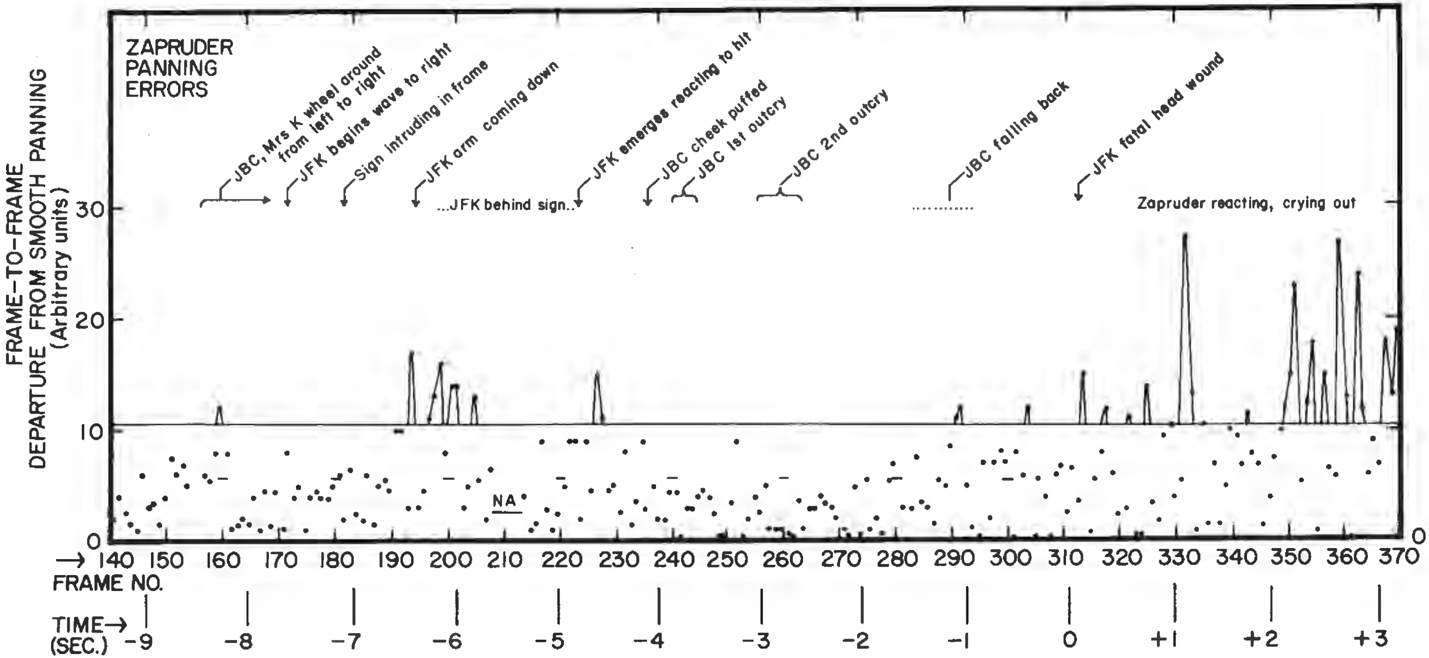


FIGURE II-4.—Errors in smooth tracking, as measured from one frame to another by Frank Scott. (Measures were reduced from Scott's graphs to numerical measures presented here by W. K. Hartmann, by method described in text.)

(87) Following our measurement of blur by these two different methods of the panning errors, the results of Luis Alvarez' study, reported in the *American Journal of Physics*, vol. 44, p. 813 (1976), were also reviewed. Instead of measuring the blur itself, Dr. Alvarez measured the difference in blur between frames and calculated the rate of change in blur, thus providing a sensitive record of any unusually erratic movement by Zapruder. All three sets of measurements were plotted on a single graph and used in the subsequent analysis. (See fig. II–5.)

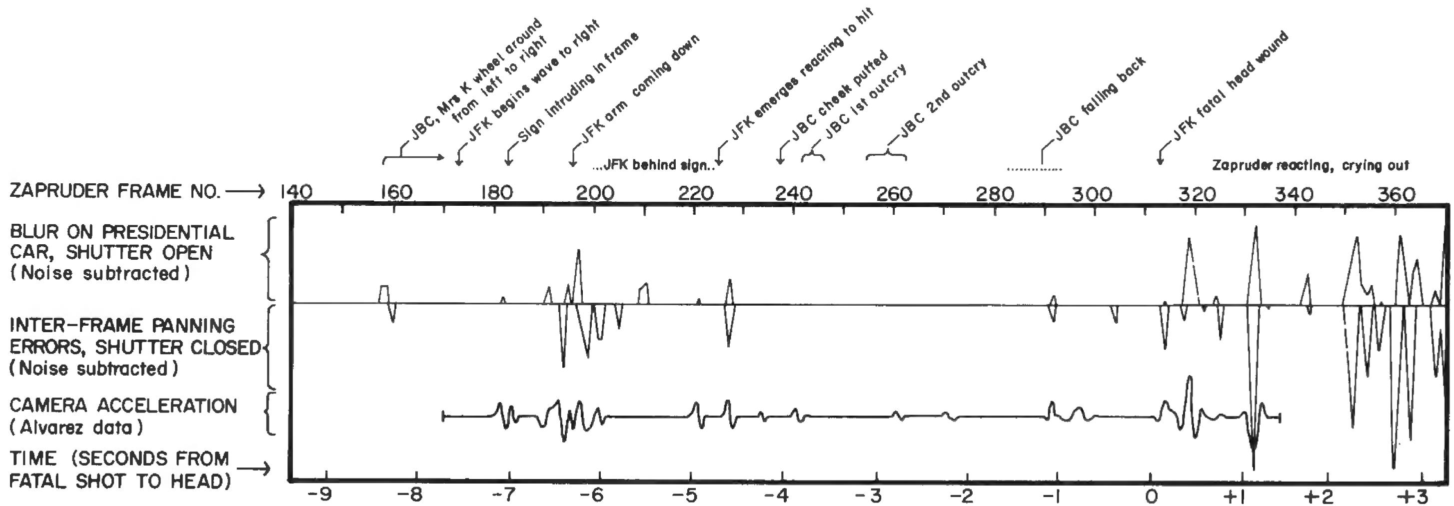


FIGURE II–5.—A comparison of the three independent records of largest blurs or tracking errors, in the Zapruder film, as derived by W. K. Hartmann (top, above line), Frank Scott (top, below line), and L. Alvarez (bottom). Magnitude of blur or panning error is indicated by length of curve upward or downward along direction of vertical axis. Frame numbers and times in seconds are given at top and bottom along horizontal axis.

(88) To assist in the analysis, a time-scale in seconds was added to figures II–1, 4 and 5. The zero point in the time-scale was chosen to coincide with the moment when the trigger was pulled on the fatal head shot. This was estimated to have been at frame 310, based on estimates of the average running speed of Zapruder's camera in conjunction with other scientific evidence.

(89) Specifically, Zapruder reported that his camera was fully wound when he started filming the motorcade as it turned onto Elm Street. In 1964, the FBI tested the camera and found that during the first 30 seconds of its operation (after being fully wound) Zapruder's camera ran at between 18.0 and 18.5 frames per second, with the average estimated to be 18.3. Note that the range 18.0 to 18.5, indicates a range of 3 percent uncertainty in all time intervals measured from the Zapruder film. (*25*)

(90) Fragmentary material from the President's head is seen flying upward and outward in frames 313 and 314. The fragments are already airborne and in motion in frame 313. Extrapolation backwards indicates that the explosion began in frame 312 rather than 313, since this would be the frame nearest to the moment when the fragments left the head. Other scientific evidence, such as wound measurements, and trajectory analysis, indicated that the fatal head shot was fired from a Mannlicher-Carcano rifle located in the southeast corner window of the sixth floor of the Texas School Book Depository.(*26*) The distance from that window to the limousine at frame 312 is approximately 265 feet.(*27*) Since a Mannlicher-Carcano bullet travels at approximately 2000 feet per second,(*28*) the bullet flight time would have been 0.13 second, or the passage of approximately 2.4 frames in Zapruder's camera. Subtracting these two frames from frame 312, it is apparent that the fatal shot was fired at approximately frame 310.

(91) Using frame 310 as the time of the trigger pull, it is possible to determine that the sound from that shot would have reached Zapruder at frame 313–314: Zapruder was standing approximately 270 feet from the Texas School Book Depository window, sound travels slightly more than 1,100 feet per second. (*29*) and the sound of the shock wave from the bullet itself reached Zapruder slightly before the sound of the muzzle blast from the window.

Finally, the pattern of jiggles that was discovered was compared with the results of the committee's acoustics study. The correlation between the jiggle analysis and the acoustics test is treated separately in an addendum to this report.

(c) *Conclusions*

(92) 1. Two pronounced series of jiggles or blurs on the Zapruder film, one during frames 189–197, a time when other visual evidence suggests that President Kennedy was first shot, (*30*) and another during frames 312–334, following impact of the head shot, may reasonably be attributed to the photographer's startle reaction to the sound of gunshots.

(93) 2. The timing of the shots associated with these two sets of blurs can reasonably be determined to be approximately 6 to 7 seconds apart.

(94) 3. Other blurs which might relate to gunshots, appear on the

film both between these two sets and elsewhere. Due to the absence of other visual evidence associated with these blurs, the Panel made no finding as to their cause.

(*d*) *Analysis*

(95) As noted above, the sound from the fatal head shot would have reached Zapruder at frame 313–314. Frame 313 is also the moment when the head explosion became visible to Zapruder. The largest blurs or jiggles on the three independent data sets of Hartmann, Scott, and Alvarez occur between frames 312 and 334. Because some of the jiggles are minor and appear on one or two of the data sets but not all three, it is difficult to determine exactly when the reaction in question actually started. The Hartmann data set shows a very large blur in frame 318 with smaller ones at 313 and 314. (See fig. II–1.) The Scott measurements show several smaller jiggles between 313 and about 324. (See fig. II–4). The Alvarez data show the largest acceleration of camera motion at 315, but with a cluster of motions from 312 to 322. (See fig. II–5.) Empirically, it appears, therefore, that Zapruder's startle reaction apparently occurred about 1 to 5 frames, or about 0.05 to 0.3 seconds after the sound reached him.

(96) In fact, the Panel found some empirical corroboration for this conclusion. Startle reaction times in response to the sound of gunshots were measured in the experimental work of Landis and Hunt in 1939. (*31*) For "head movement," "movement of neck muscles," and "initiation of arm movement," Landis and Hunt found that the reaction time was 0.06 to 0.2 second (i.e., 1.1 to 3.7 frames). (*32*) Thus, these much earlier experimental findings support the conclusion that the film actually records Zapruder's startle reaction to the fatal shot immediately after Zapruder heard the sound of the shot and saw the head impact through his viewfinder.

(97) In all three data sets, the second longest and second greatest (in terms of magnitude of blur or jiggle) disturbance in camera panning motion occurs between frames 189 and 197. Since our objective is to estimate the time the shots were fired, the blurred frames of most interest are those from the jiggle's beginning to its peak rather than to its decline. For the various data sets, the time from the first strong increase in blur to the maximum blur or jiggle is as follows: Hartmann, 191–197; Scott, 193–194; and Alvarez, 189–195. (See figs. II–1, II–4, and II–5.)

(98) Assuming that a shot from the sixth floor Texas School Book Depository window caused this reaction (a distance at this point in time of approximately 165 feet from the limousine) (*33*), and that Zapruder's reaction was again almost immediate (within 1 to 4 frames after hearing the shot), it is possible to calculate backward (adding sound travel time to Zapruder of 4 frames, to reaction time of 1 to 4 frames), and determine that the shot may have been fired between frames 181 and 192, and impacted in the limousine between frames 182 and 193. This conclusion is reinforced somewhat by the Photographic Evidence Panel's visual observation of the Zapruder film which reflected a reaction by President Kennedy to some severe external stimulus by frame 207 when the President disappears behind a sign frame. (*34*) Assuming a uniform reaction time in both cases by Zapruder, and that both shots originated in the same location (the

sixth floor window), the trigger pull on this shot would have preceded that of the fatal head shot by approximately 6.3 to 6.9 seconds (minimum, 313–197 over 18.5 equals 6.3; maximum 313–189 over 18.0 equals 6.9).*

(99) The blur or jiggle results have been examined for other blur episodes that possibly correlate with additional gunshots. The three next largest episodes of blur are listed in table 1, in which the largest and second largest blur episodes discussed above are designated A and B. The third, fourth, and fifth largest blur episodes, which are similar to one another in magnitude, are listed respectively as C, D, and E.

(100) It is difficult to determine with certainty whether any of these represents an additional shot or shots. Blur episode C, detected by all three analysts, occurs at frames 220–228, just before movements of Governor Connally in which his cheeks suddenly puff out and his face contorts in a grimace, followed by two apparent outcries in which his mouth opens wide in what appears to be a shout of pain.

(101) Another shot could have caused blur episode D at frames 158–160. It occurs much earlier in the motorcade than had been considered possible for a shot by either the Warren Commission or most Warren Commission critics. Nonetheless, this brief blur was detected by both Hartmann and Scott; Alvarez published no data for such an early part of the motorcade because he used the Warren Commission volumes which do not even reproduce Zapruder frames earlier than the mid-170's. The most interesting thing about this hypothetical shot is that Mrs. Kennedy and Governor Connally testified before the Warren Commission and Governor Connally testified before the select committee that they turned to their right when they heard the first shot, (*35*) and both are seen in the film beginning a turn to the right immediately after this hypothetical shot. This appears particularly striking in the case of Governor Connally, whose head turns from midleft to far right in less than half a second, beginning at frame 162.

(102) A fifth episode (E) possibly associated with a shot occurs at frames 290–293. Although it contains a very small blur detected by both Hartmann and Scott, as well as a more substantial blur in Alvarez' data, the Panel found no visual indications of reactions to a shot by the limousine's occupants coinciding with this segment of blur in the film.

(103) Other jiggles or blurs were present in the photographic record. (See fig. II–5.) Without further data, however, the magnitude and duration of these jiggles, as those with characteristics of C, D, and E, are insufficient to warrant any conclusion concerning the number and timing of any additional gunshots.

---

*Assuming a uniform reaction time, and a uniform distance of Zapruder from the shooter, it is possible to ignore delays caused by sound travel from the shooter to Zapruder and Zapruder's reaction time in calculating the spacing of the two shots, since any assumed value for such delays would be self-canceling in the calculation.

TABLE I.—BLURS IN ZAPRUDER FILM

Relative magnitude of blur episode	Designation of blur episode	Shown by	Frames showing blur onset (beginning to maximum)
Largest	A_1	Alvarez	312–318
		Hartmann	313–318
		Scott	313–314
	A_2	Alvarez	330–334
		Hartmann	331–332
		Scott	331–333
2d largest	B	Alvarez	189–195
		Hartmann	191–197
		Scott	193–194
3d largest [1]	C	Alvarez	220–228
		Hartmann	227
		Scott	226–228
4th largest [1]	D	Hartmann	158–159
		Scott	158–160
5th largest [1]	E	Alvarez	291–293
		Hartmann	290–291
		Scott	290–292

[1] About equal.

ADDENDUM

Comparison With Results of the Acoustics Analysis

(104) The acoustics analysis suggests the possibility of four shots, the first, second, and fourth originating from the Texas School Book Depository and the third having been fired from the grassy knoll. (*36*) This appendix discusses the extent of agreement between the acoustic timings and the major blurs on the Zapruder film.

(105) A first step in comparing the acoustic results to the blur analysis would be to line up one of the shots indicated by the acoustics analysis with the known fatal head wound to the President. This cannot be shots No. 1 or No. 2 from the acoustics analysis because the President's reaction to the back wound, at approximately frame 200 would then occur before any shooting. Therefore, the fatal head wound had to be shot No. 3 or No. 4. It is improbable that the fatal head shot was shot No. 3 because the acoustics analysis places this shot as coming from the grassy knoll, while the medical and other scientific evidence indicates that the President's head was struck from the rear. (*37*) The fatal head shot, therefore, was probably the last shot identified in the acoustics analysis.

It is thus a simple step to work backward in time from that final shot to derive the times that Zapruder heard shots based on the acoustics results. The acoustics report states that the time intervals between the four shots recorded on the Dallas Police Department tape are 1.57, 5.63, and 0.71 seconds respectively, (*38*) but that the Dallas Police Department recorder was running approximately 5 percent too slow. (*39*) Adjusting for this 5-percent error, the actual spacing of the shots to the nearest one-tenth second would therefore be 1.6, 6.0, and 0.7 seconds.

(106) As noted earlier, the FBI tested Zapruder's camera in 1963. They found that its speed varied from 18.0 to 18.5 frames per second during the first 30 seconds of its operation (after being fully wound), and then ultimately decreased to 17.6 frames per second before it completed the next 30 seconds of its operation. Because Zapruder said his

camera was fully wound when he began filming the motorcade, it may be assumed that the camera ran between 18 and 18.5 frames per second during the approximately 8 seconds of the assassination. Using these parameters for film speed, and allowing for sound and bullet travel times, the frames exposed when the bullets would have reached the limousine, and when Zapruder would have heard the muzzle blast, can be calculated. (See cols. 3 and 4 of top of table II.)

(107) In constructing and then using table II, a note of caution is appropriate: Any calculation of the frames exposed, based upon a correlation with the sound impulses on the Dallas Police Department tape, should not be presumed to be absolutely precise because only the average, and not the precise, running speeds for the camera are known, and the tape speed adjustment of 5 percent is similarly only an average. Thus, table II reflects mathematical calculations of frame numbers utilizing the available averages, that is, a tape speed adjustment of 5 percent (although the tape may have actually been closer to 4½ percent or 5½ percent slow at times) and the parameters of 18.0 to 18.5 frames per second camera speed. The actual frames when an event occurred may have been a frame or two different than the calculations based upon such estimated averages.

(108) As can be seen from columns 3 and 6 of the table, there is good correlation for shots 1, 2, and 4, where in each case the blurs occur when the acoustics data reflect Zapruder would have heard the shots. On the other hand, there is no correlation (except possibly for the Scott measurements) for shot No. 3, since the blur at 289–293 precedes the arrival of sound at Zapruders' location and thus could not have been a product of his startle reaction to that sound.*

(109) The same calculations and comparisons can be made using the assumption that the third shot (the one from the grassy knoll) caused the head wound at frame 312. This process is reflected in the lower portion of table II. Here there are blurs following each shot, the first two lagging behind Zapruder's hearing of the sound by 9 to 12 frames (½ to ⅔ second), and the second two immediately following his hearing the sound.

---

*There is one relatively small panning error between frames 300 and 305 detected by Scott's technique. See figure II–4.

TABLE II

IF THE FOURTH SHOT CAUSED THE FATAL HEAD WOUND					
ACOUSTICS STUDY				PANNING ERROR - BLUR ANALYSIS	
Unadjusted Tape Time	Adjusted Spacing *	Frames Exposed When Zapruder Heard Shots	Frames Exposed At Bullet Impact	Blur Episode**	Blurred Frames
137.70		159-165	157-161	(D)	158-160
	1.6				
139.27		191-194	188-191	(B)	189-197
	6.0				
144.90		296	295-296	(E)	290-293
	.7				
145.61		313-314	312	(A_1)	312-318
IF THE THIRD SHOT CAUSED THE FATAL HEAD WOUND					
137.70		175-181	173-177	(B)	189-197
	1.6				
139.27		208-210	205-208	(C)	220-228
	6.0				
144.90		312	312	(A_1)	312-318
	.7				
145.61		330	328-329	(A_2)	330-334

* These times are the adjusted spacing of the sound impulses on the Dallas Police Department tape recording, and not the spacing of trigger pull or bullet impact times, which would vary somewhat from these times based upon the distances between the weapons, the limousine, and the motorcycle microphone that transmitted the sounds.
** The blur episodes are taken from Table I.

4. THE TRAJECTORY ANALYSIS*

(a) Introduction

(110) A trajectory is the path taken through space by an object such as a missile or bullet. In general, the trajectories of missiles are curved because of factors such as gravity and aerodynamic forces. Nevertheless, in the case of high speed bullets traveling short distances, the curvature is typically slight. (*40*) In such cases, the effect of aerodynamic forces is small both because the projectile flies almost perfectly nose-on through the air and because any small side-to-side movements tend to cancel one another by virtue of the bullet's spin. (*41*) The effect of gravity is similarly slight and can be easily calculated. For a total flight path of 200 feet at 2000 feet per second (the speed of a bullet from a moderate performance rifle), the time in flight is one-tenth of a second. During this period, gravity deflects the flight path only two inches.(*42*) A high performance rifle bullet would be deflected even less because it is traveling faster and its time in flight is shorter. It is, therefore, permissible to characterize the trajectory of each bullet fired at the President as a straight line extending between rifle and victim.

(b) Issues

(111) In connection with the trajectory analysis, the Panel undertook to answer three questions:

* This section was prepared under the direction of Thomas N. Canning, with the assistance of Clyde C. Snow and C. S. McCamy. For the related public hearing testimony of Canning and McCamy, see HSCA–JFK Hearings, 9/12/79, vol. II, pp. 142–203.

(112) 1. What were the trajectories of the bullets that struck the President?
(113) 2. Is the trajectory of the bullet that caused the President's back and neck wounds consistent with the single bullet theory?
(114) 3. Given the trajectories, from where were the bullets fired?

(c) Procedures

(115) A straight line trajectory can be constructed once any two points the missile is known to have passed have been established. In the present study, the inshoot and outshoot wounds inflicted by the bullets that struck President Kennedy and Governor Connally were used as the two points.
(116) In order to calculate the trajectory based on these wound pairs, it was necessary to establish the position of each entry and exit point in space at the time it was inflicted. This requires that three determinations be made:
(117) 1. The location of the wounds relative to recognizable reference features of the victim had to be established. Ideally, this information could be expressed in terms of a measured distance left or right from the midplane of the body along well-defined directions in reference to clear external features such as an ear or elbow.
(118) 2. It was necessary to determine the angular orientation of the wounded part of the victim relative to his immediate surroundings—that is to say, in what direction he was facing, what his inclination was forward or backward, and to which side he was leaning and by how much.
(119) 3. It was necessary to know where the victim was located relative to his surroundings, i.e., the location of the victim within the limousine and the location of the limousine relative to known landmarks in Dealey Plaza.
(120) The requisite information for undertaking this particular trajectory analysis could not be accurately obtained from any single source. Consequently the committee asked its various scientific consultants to provide input from their areas of expertise. The Forensic Pathology Panel was responsible for providing, to the extent possible, the precise locations of the wounds sustained by Kennedy and Connally.* It relied on enhanced postmortem photographs and X-rays of President Kennedy which were produced by the Photographic Evidence Panel. Enhanced photography was further used in the effort to determine the precise orientation of President Kennedy at the time of the assassination. The Photographic Evidence Panel also assisted in the interpretation of motorcade photographs of Kennedy and Connally and in providing photogrammetrically derived measurements of critical aspects of the photographs. Finally, the actual placement of the presidential limousine in the Dealey Plaza area at the time of the

*While the Forensic Pathology Panel did provide this information, the actual measurements related to wound locations were determined by the NASA scientist who was responsible for supervising the trajectory project. He was in frequent consultation with members of the Forensic Pathology Panel and with forensic anthropologists from both the FAA's Civil Aeromedical Institute and the Smithsonian Institute.

shots was established through a photogrammetric analysis conducted by the U.S. Geological Survey (USGS).[1] (*43*)

(121) All the preceding information was compiled under the supervision of Thomas N. Canning, an engineer from the Space Project Division of NASA, who then was responsible for constructing the actual trajectories. In contrast to the trajectory analysis performed by the Warren Commission, (*44*) the investigative procedures and analyses in this instance were governed by the hypothesis that there was no other evidence (e.g., the discovery of bullet cartridges and a rifle in the Texas School Book Depository) concerning the source of the shots.

(122) Although all of the available scientific evidence indicated that President Kennedy and Governor Connally were struck by a total of two bullets, one hitting President Kennedy in the back and continuing through to enter Governor Connally after exiting President Kennedy's neck, and the other hitting President Kennedy's head, three different trajectories were constructed: One based on the entry and exit wounds to President Kennedy's head, another on President Kennedy's back-neck wounds, the last on the exit wound to President Kennedy's neck and the entry wound to Governor Connally's back.[2] The first two trajectories were constructed for the purpose of determining whether the two shots were fired from the same location and the third to determine whether the relative alinement of President Kennedy and Governor Connally in the limousine was consistent with the single bullet theory.

(*d*) *Conclusions* [3]

(123) *Kennedy's head wounds.*—The bullet that caused Kennedy's head wounds at Zapruder frame 312 came from a point 29° to the right of true north from the President. The bullet was descending at an angle of 16° below horizontal as it approached him. This trajectory intercepted the plane of the Texas School Book Depository approximately 11 feet west of the southeast corner of the building at a point 15 feet above the sixth floor windowsills.

(124) *Kennedy's back and neck wounds.*—The bullet that caused President Kennedy's back and neck wounds came from a point 26° to the right of true north from the President. It was descending at an angle of 21° below horizontal as it approached him. Extending this trajectory from the position President Kennedy occupied at the time of Zapruder frame 190, the trajectory intercepted the plane of the Texas School Book Depository approximately 11 feet west of the southeast corner and 2 feet lower than the sixth floor windowsill.

(125) *Kennedy neck and Connally back wounds.*—The bullet which caused President Kennedy's neck wound and Governor Connally's back wound came from a point 27° to the right of true north from the Presi-

---

[1] USGS was asked to determine the position of the limousine at times corresponding to Zapruder frames 150, 190, 285, 313, and 413; however, because some of these frames did not provide the required visual coordinates, the nearest frame with sufficient reference points was used.

[2] No trajectory analysis based solely on the wounds suffered by Connally was attempted because the bullet that struck him in the back hit at least two bones (at oblique angles) and was consequently significantly deflected.

[3] Explanatory diagrams supporting these conclusions are set forth in the analysis section of this report.

dent and was descending at an angle of 25° below horizontal.

(126) Given the position of the two men at the time of Zapruder frame 190, the trajectory intercepted the plane of the Texas School Book Depository 2 feet west of the southeast corner and 9 feet above the sixth floor windowsill. Because this trajectory falls within the trajectory range established when President Kennedy's back-neck wounds are used as the reference points for the trajectory line, the Panel concludes that the relative alinement of President Kennedy and Governor Connally within the limousine is consistent with the single bullet theory. Further, since each of these trajectories intersects the plane of the Texas School Book Depository in the vicinity of the southeast corner of the sixth and seventh floors, it is highly probable that the bullets were fired from a location within this section of the building.*

(e) *Analysis*

*(1) The head wound case**

(127) To determine this trajectory, the Panel first had to locate the entrance and exit head wounds as precisely as possible. Figures II–6 and II–7 show where the fatal bullet entered the back of President Kennedy's head at a point 9.0 centimeters above the external occipital protuberance. (*45*) This distance was measured on postmortem X-rays from point to point. The entry point is 1.8 centimeters to the right of the midplane of his skull. The bullet passed forward through his head and exited at the right coronal suture at a point 11 centimeters forward of the entry wound and 5.5 centimeters to the right of the midplane. This exit point was 1 centimeter lower than the entrance wound, using as the exterior vertical reference a line drawn through the President's brow and upper lip. Thus the bullet was traveling 18.6° to the right relative to his midplane and 5.0° downward relative to his facial axis.

---

*The above conclusions differ to some extent from the testimony given by Thomas N. Canning before the House Select Committee on Assassinations on Sept. 12, 1978, in each case, the differences reflect new information or analysis resulting from work concluded subsequent to the presentation of preliminary findings at the heading.

*The interpretation of the head wounds used in defining trajectory reported in testimony on Sept. 12, 1978 differs from this report because the final illustration from the Forensic Pathology Panel showed the exit wound to be 1 centimeter lower than the entrance, rather than level with it as had been concluded earlier. Thus, the resulting trajectory is somewhat steeper.

LOCATION OF HEAD WOUNDS IN PRESIDENT KENNEDY

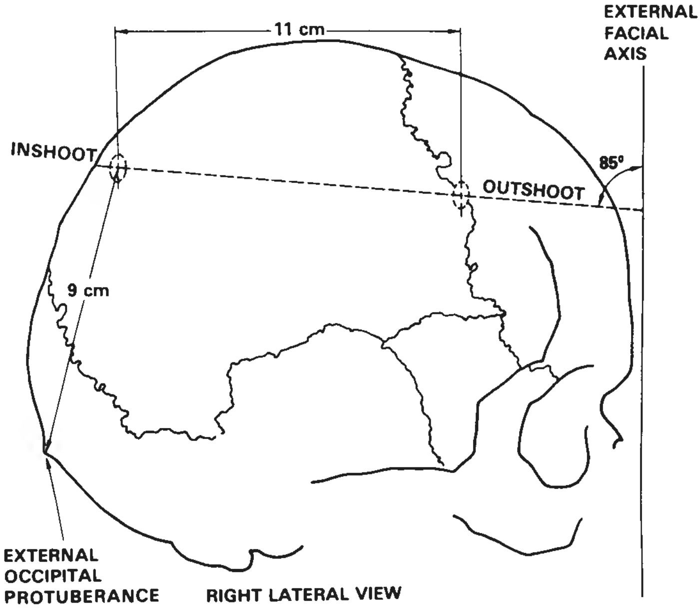


FIGURE II–6

LOCATION OF HEAD WOUNDS IN PRESIDENT KENNEDY

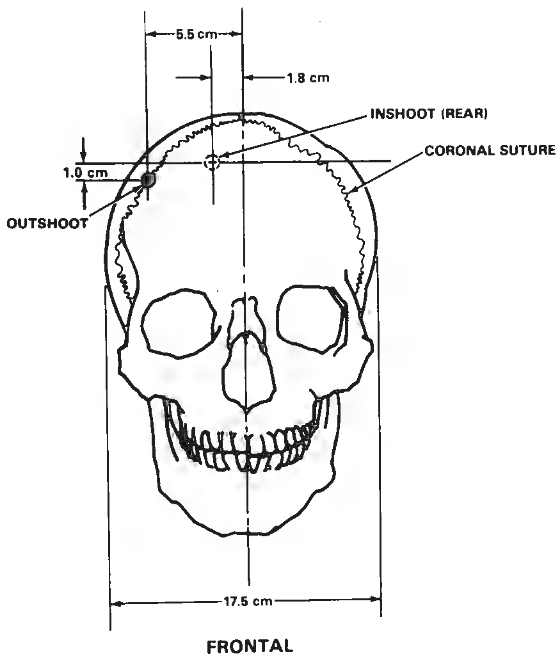


FIGURE II–7

(128) Once these wound locations were established, derivation of the bullet's trajectory still required knowledge of the orientation of Kennedy's head relative to Dealey Plaza. Establishing this relationship from the photographs was most easily accomplished in two steps: (1) finding the position of Kennedy's head relative to the line of sight to Zapruder's camera, and (2) accounting for the orientation of that line relative to the entire Dealey Plaza area.

(129) The Zapruder and Nix films showed the position both of Kennedy's head and of suitable reference structures in the field of view such as walls, street lights, and curbs. Since Kennedy's head is seen exploding in frame 313 of the Zapruder film, frame 312, which was exposed 0.055 seconds earlier, was considered to be the most important photograph available for this aspect of the trajectory analysis. (See JKF exhibit F-254.)

(130) The key features to be analyzed in frame 312 with respect to determining the orientation of Kennedy's head, were the lateral and vertical position of his right ear relative to the outline of the head and the overall relationship between his ear, nose and eyebrow. Rather than basing the analysis on a purely subjective interpretation, orientation was determined by comparing these features, as they appeared in an enhanced print of Zapruder frame 312 (see fig. II-8, JFK exhibit F-134), with a series of calibration photographs of a replica of Kennedy's head prepared by the Civil Aeromedical Institute of the

FIGURE II-8

FAA's Aeronautical Center.* These calibration photographs were taken from many carefully measured aspects (lines of sight), including several which closely approximated the relative location of Zapruder's camera at frame 312. (See fig. II–9, JFK exhibit F–141.)

FIGURE II–9.—Calibration photograph corresponding with Zapruder frame 312.

(131) After studying those protographs most closely approximating the correct aspect, it was possible to determine, by comparing the positions of such features as Kennedy's ear relative to other parts of his head, the aspect from which Zapruder's camera viewed Kennedy. On this basis, it was determined that Kennedy was turned partially away from Zapruder—approximately 25° past the 90°, or profile, direction. His head was tilted away from Zapruder by about 15°, and he appeared to be nodding forward by about 11° (clockwise, as viewed by Zapruder).

(132) In order to obtain a similar set of relationships relative to landmarks in Dealey Plaza, it was necessary to establish the orientation and position of this line of sight. Its direction and the point where it intercepts Kennedy's head were determined by drawing a line on a scaled map of Dealey Plaza between Zapruder, whose position had been derived from other photographs and testimony, and Kennedy at the geographic position on the street corresponding to the limousine's location at the time that Zapruder frame 312 was exposed. The latter was determined by relying on the photogrammetric

* The construction of the replica and the taking of the calibration photographs are described in addendum A, at pars. 169–176 *infra*.

analysis of the USGS. (*46*)* (See fig. II–10, JFK exhibit F–133.) The slope of this line was calculated by considering the relative heights of both the pedestal on which Zapruder was standing and of the street at the point where the limousine was located at frame 312, and then measuring the distance between Zapruder and Kennedy.

(133) The pedestal on which Zapruder stood was 12 feet above the point on Elm Street occupied by Kennedy at the time of Zapruder frame 312. When both the height at which the camera was held and the height of Kennedy's head above the street were considered (about 5 feet and 4 feet, respectively), the camera was determined to have been about 13 feet higher than Kennedy. The distance between Kennedy and Zapruder was about 70 feet at the time of the fatal shot. (See fig. II–10, JFK exhibit F–133.) Given this height difference and the distance between the two men, a line of sight downward from Zapruder to Kennedy was computed to be at an angle of 10°.

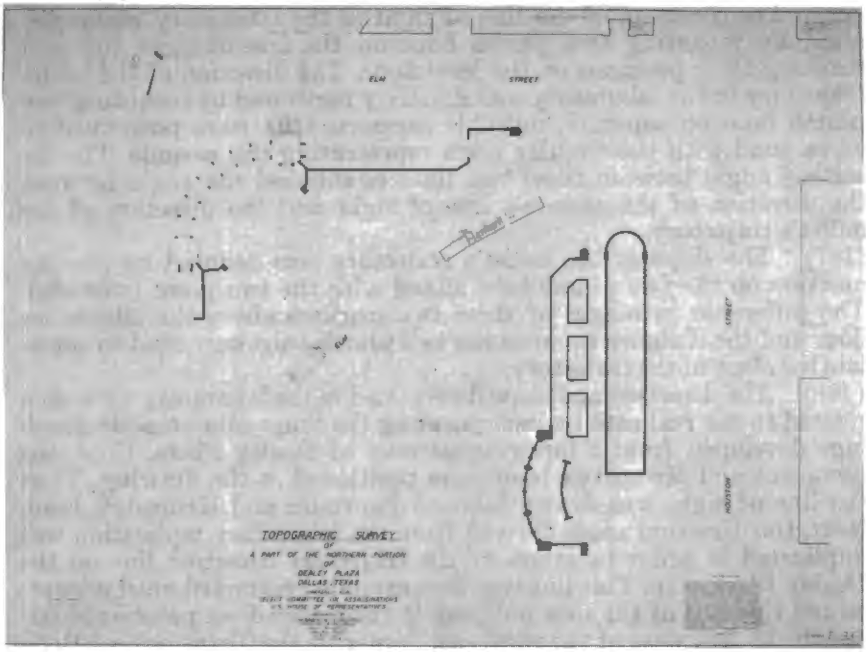


Figure II–10

(134) Once these factors had been established, the geometric relationship between the line of sight from Zapruder's camera and the trajectory line defined by the inshoot and outshoot wounds in Kennedy's head was determined.

(135) A physical reconstruction, consisting of a wooden mockup based on the photographic analysis of Zapruder frame 312, was used.

***Because Zapruder frame 313 provided better reference points, the USGS used that frame to determine the location of the limousine. Based on the limousine's estimated average speed, an adjustment of 1 foot was made to locate the vehicle at frame 312.**

In the mockup, the camera line of sight was represented by a straight dowel. The midplane of Kennedy's head was represented by a flat piece of wood to which the line-of-sight dowel was affixed in a manner reflecting its relative slope and direction. A second straight dowel was installed vertically at the front of the midplane to represent the external facial axis defined by the forehead and upper lip. Finally, to simulate the location of the entry and exit wounds, two short posts were fastened to the midplane 11 centimeters apart and extending 1.8 and 5.5 centimeters outward on the same side as the line-of-sight rod. These posts were fitted with circular tips—one open and the other solid—to serve as sighting points. The positions of the posts relative to the facial axis and line-of-sight rods duplicated the positions of the wounds as located by the Forensic Pathology Panel.

(136) This assembly was then supported on a photographer's tripod in a laboratory so as to duplicate the slope of the line of sight of Zapruder's camera and the inclination of the facial axis simultaneously. The direction of the line of sight in the laboratory was registered by mounting two plumb bobs on the line-of-sight rod and marking their positions on the level floor. The direction of the bullet trajectory in the laboratory was similarly registered by mounting two plumb bobs on separate, movable supports that were positioned to correspond with the circular posts representing the wounds. The resulting angle between these two lines established the angle between the direction of the camera's line of sight and the direction of the bullet's trajectory.

(137) The slope of the bullet's trajectory was deduced by placing markers on the two plumb bobs alined with the two posts (wounds). The difference in height of these two markers above the laboratory floor and the distance between the two plumb bobs were used to calculate the slope of the trajectory.

(138) The direction and slope determined in the laboratory were then related to the real case by incorporating the same data on scale drawings developed from a topographic map of Dealey Plaza. First, the limousine and Kennedy's head were positioned in the drawing. Then the line of sight was drawn between Zapruder and Kennedy's head. Next, the direction angle derived from the laboratory replication was duplicated in order to arrive at the trajectory direction line on the Dealey Plaza map. This line was then extended rearward until it intercepted the face of the first building it encountered—a point approximately 11 feet west of the southeast corner of the Texas School Book Depository. (See fig. II-11.)

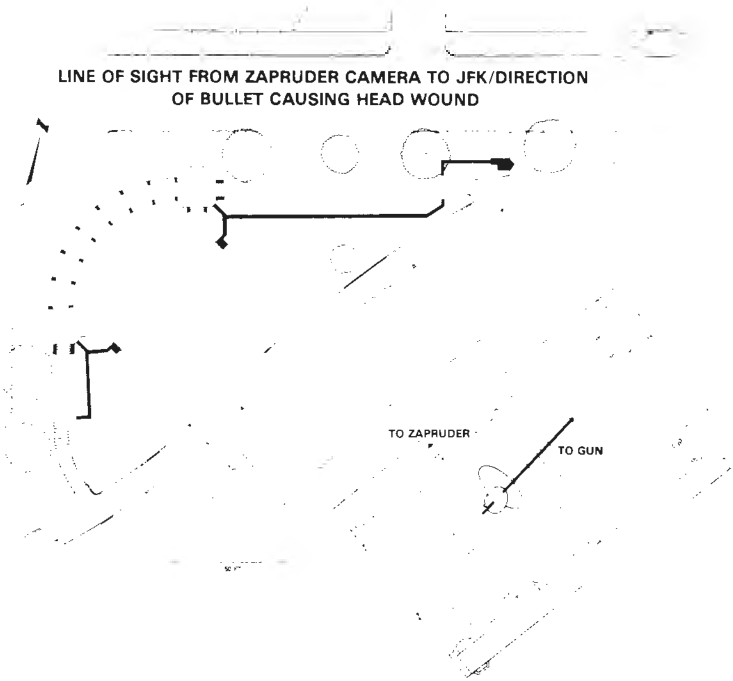


FIGURE II-11.—This diagram depicts the line of sight from Zapruder's camera to President Kennedy and the trajectory direction of the bullet that caused the fatal head wound. Note that the limousine shown at the right is an enlargement of the one drawn in the middle of the diagram.

(139) In order to show the slope of the trajectory without distortion, it was necessary to develop an oblique elevation view shown in fig. II-12. This view is an orthogonal projection onto a vertical plane parallel to the bullet's trajectory. In this view, the resulting trajectory slope of 16° is shown to intersect the Texas School Book Depository at a point approximately 11 feet west of the southeast corner of the building and 15 feet above the sixth floor windowsills.*

* The revision in relative heights of the inshoot and outshoot wounds in Kennedy's head resulted in most of the difference in this trajectory from that presented in testimony before the House Select Committee on Assassinations on September 12, 1978. The remaining revisions resulted from the availability of a superior enhanced reproduction of Zapruder frame 312 for comparison with the calibration photographs.

LINE OF SIGHT FROM ZAPRUDER CAMERA TO JFK/SLOPE OF BULLET CAUSING HEAD WOUND

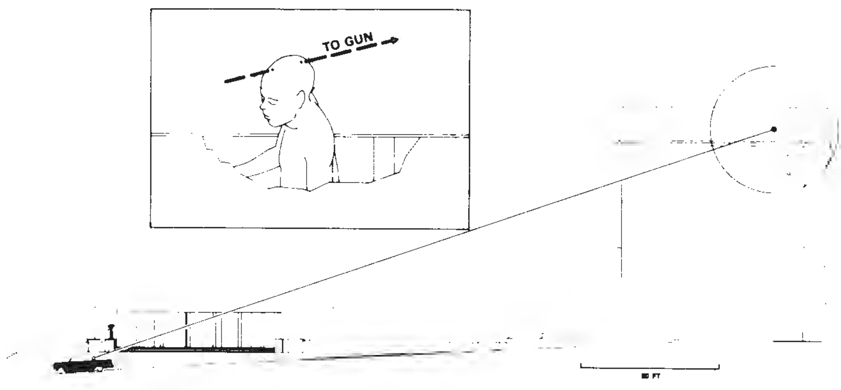


FIGURE II–12

(140) A circle with a radius of 23 feet has been drawn around the intersect point in figure II–12 represents the estimated minimum reasonable margin of error for this trajectory analysis.* To derive this estimate of the margin of error, each step in the analysis was checked for possible errors. Factors such as the position of Zapruder and Kennedy and the height of the pedestal on which Zapruder stood were not considered significant sources of error. The major uncertainties related to the wound positions and the orientation of Kennedy's head relative to Zapruder.

(141) For example, of critical importance in comparing calibration photographs with Zapruder frame 312 was the apparent position of Kennedy's right ear in relation to his nose, brow and back of head. An error of 1.0° (equal to about 0.16 centimeter), in positioning the ear on the replica of the head would yield approximately 1.0° error in the deduced trajectory ** if not offset by other factors in interpreting the photographs or elsewhere. Similarly, establishing the relationship of those elements critical in determining the degree to which Kennedy's head was nodding forward (for example, the line from his brow to his upper lip relative to the slope of the street) also required careful and repetitious measurements to minimize errors. All measurements were made repeatedly, using as many independent image cues as could be found. The redundancy of the cues selected and the repetition of the studies, coupled with the probable random direction of any errors introduced, allows the Panel to conclude that a liberal estimate for the margin of error is about 5° (that is, a 23-foot radius around the intersect point at the Texas School Book Depository).

(2) The back-neck case

(142) According to the autopsy photographs, the first bullet to strike Kennedy entered his back slightly about his shoulder blade and slightly to the right of his backbone. (See fig. II–13.) This bullet passed

---

*That is to say that the margin of error could be greater.

**A 1-degree error results in a movement of about 4 feet at a range of 250 feet.

through soft tissue hitting no bone, and exited at the front of his neck. (*47*) Independent determinations by the Photographic Evidence Panel showed the entrance wound to be from 4 to 5 centimeters from Kennedy's center plane and the exit wound to be on the center plane or as much as 0.5 centimeters to its left. When seen in the autopsy position, the outshoot wound was described as being at about the same height (or slightly higher) relative to the inshoot wound. The distance between the wounds was determined to be 14 centimeters.

J.F.K. WOUND LOCATIONS

FIGURE II-13

(143) Based on the acoustics results (*48*), the camera blur study (*49*) and the visual observations made by the Photographic Evidence Panel, (*50*) it was determined that Kennedy was struck by this bullet at a time corresponding approximately to Zapruder frame 190. Accordingly, to determine Kennedy's orientation at that point, frame 190 and adjoining frames were closely scrutinized. (*51*) (See JFK exhibits JFK F-225-227.)

(144) The best record of Kennedy's posture, torso inclination, and shoulder "hunching" is a photograph taken by Robert Croft at about the time of Zapruder frame 161. (*52*) (See fig. II-14, JFK exhibit F-135.) This correlation was established by the Photographic Evidence Panel by examining features in the Croft photograph and studying Croft's movements as recorded in the Zapruder film.

(145) In Croft's picture, Kennedy and other persons in the limousine are seen from a perspective that permits a reasonable determination of their posture and orientation. Kennedy's upper torso/neck region was inferred from this photograph to have been inclined forward at an approximate angle of 11° to 18° relative to a line drawn upward from and perpendicular to the road surface. The range of this angle is well within a much larger range derived from studies of many other photographs taken during the motorcade. Although the Croft photograph corresponds to Zapruder frame 161, there is no indication in the Zapruder movie that Kennedy changed his inclination substantially before he was hit in the back. (*53*) (See JFK exhibits F-226-242.)

42-370 O - 79 - 4

FIGURE II–14

(146) The Croft photograph also shows Kennedy's torso facing nearly straight forward. At Zapruder frame 190, however, he is seen to turn his head about 60° to his right (see JFK exhibit F–226), and it is reasonable to expect that he also would have rotated his shoulders a small amount in the same direction. Most probably, this rotation was only 5° or less, as judged by the absence of obvious large shifts in body position in the Zapruder movie. Thus, it was assumed that, except for turning his head by about 60° and his torso perhaps by 5°, Kennedy made no major changes in posture after frame 161. This assumption is supported by a photograph taken by Phillip Willis at about the time of Zapruder frame 202.* (See fig. II–15, JFK exhibit F–155.)

---

*Establishing when the Willis photograph was exposed in reference to the Zapruder film was done by the Photographic Evidence Panel by studying the Zapruder film and determining when Willis could actually be seen snapping his picture. In the study of the back/neck wounds trajectory, calibration photographs of the anthropometric dummy were taken but not used (that is, for measurement analysis) because, unlike the head, the torso is quite mobile, and consequently there is no stable relationship between the various body parts. It was decided that to rely on the calibration-photograph technique in this instance would have given a false sense of accuracy to the analysis.

FIGURE II–15

(147) The Panel then had to adjust slightly the wound locations that had been provided based on the autopsy photographs and X-rays because of their difference in body position from that at the time of the shooting. During the autopsy, Kennedy was in an anatomical position with his face tilted as if looking upward about 35°, a posture and conformation significantly different from those at the time of the assassination.

(148) Appropriate adjustments were made under the direction of Dr. Clyde Snow, a forensic anthropologist at the Civil Aeromedical Institute of the FAA's Aeronautical Center. It was determined that returning Kennedy's head to a normal position relative to his body would, according to laboratory tests on men of similar build, adjust his neck wound down about 1.0 centimeter toward his breastbone. Returning Kennedy's head to the position it was in at the time he was first wounded—about 60° to the right of straight ahead of his torso—caused only a slight change in the position (approximately 0.1 centimeter to the right of its observed position in the autopsy photographs). *(54)*

(149) Because the Zapruder film showed that Kennedy had raised his right shoulder slightly so as to place his elbow on the side of the limousine, the resulting movement of skin at the inshoot location was also assessed. It was found that the wound was approximately 0.1 centimeter higher and 0.2 centimeter closer to his midplane than the post mortem photographic observations by themselves indicated. *(55)* While only the vertical position of the neck wound was substantially altered by these changes in conformation, all the adjustments were included in the analysis of trajectory.

(150) Using the average locations and adjustments, the back wound was located at a point 4.4 centimeters to the right of and 1.1 centi-

meters above Kennedy's neck wound at the time of the shot. The bullet was moving from right to left by 18° and downward by 4.0° relative to Kennedy if he were sitting erect (not inclined forward or aft). Since Kennedy was believed to have been turned about 5° to his right relative to the fore-and-aft line of the limousine, it is concluded that the bullet was moving from right to left by 13° relative to the midline of the limousine. By a similar analysis, since Kennedy was inclined slightly forward by approximately 11° to 18° (from true vertical), the downward slope of the trajectory, taking into account the 3° slope of the street, was established at between 18° and 25° (4° plus 11° to 18°, plus 3°). The Panel decided to use an angle of 21° for its analysis.

(151) The analysis by the USGS of the limousine's motion through Dealey Plaza provided both the location and angular orientation of the limousine at a time corresponding to Zapruder frame 193; (*56*) adjustments were then made with reference to Zapruder frame 190. (See fig. II–10, JFK exhibit F–133.)

(152) The direction of the trajectory was then determined by drawing a line on a scaled diagram of Dealey Plaza at a 13° (that is, 18° minus 5°) angle relative to the car and extending it to the rear until it intercepted the first building that it encountered. Assuming frame 190 as the moment of impact, the trajectory line intercepts the Texas School Book Depository approximately 14 feet west of its southeast corner. (See fig. II–16). Using an angle of 21°, the slope of the trajectory was then drawn onto a similarly scaled diagram and found to intersect the Texas School Book Depository at a point almost level with the sixth floor windowsill. (See fig. II–17.)

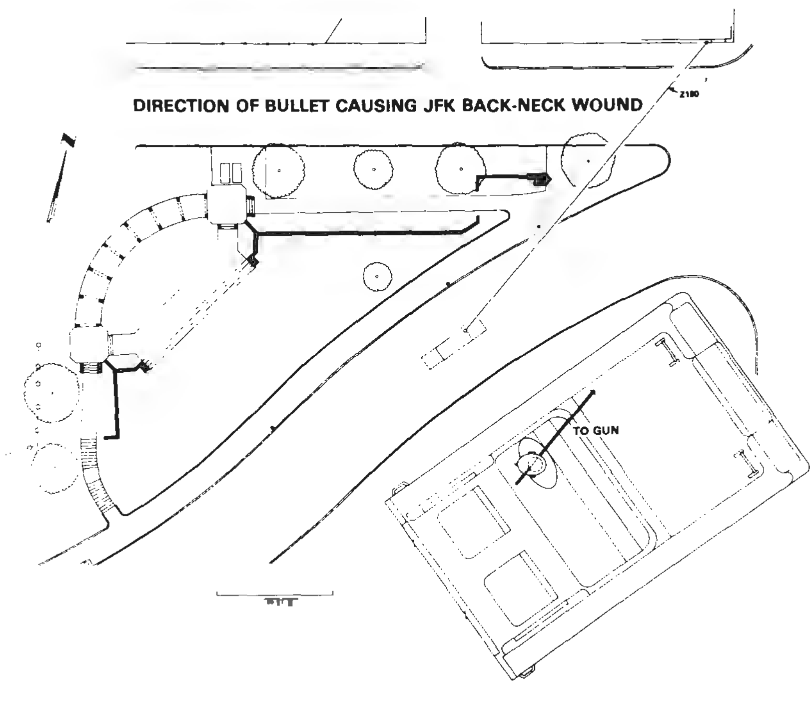


FIGURE II–16

SLOPE OF BULLET CAUSING JFK BACK-NECK WOUND

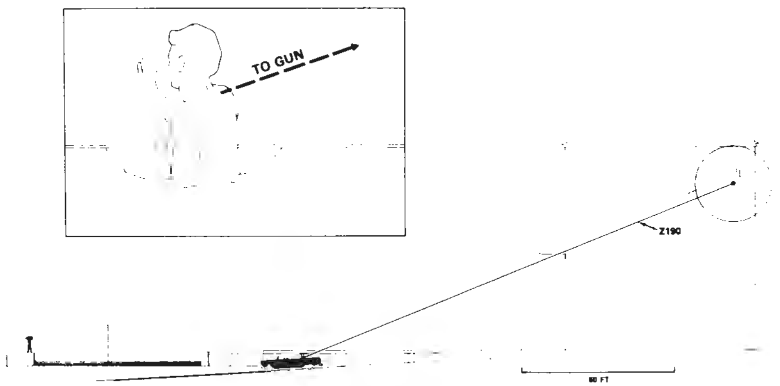


FIGURE II–17

(153) A circle with a radius of 13 feet has been drawn about the intercept point of the trajectory in figure II–16, reflecting the margin of error. It represents the estimated minimum reasonable margin of error that can be ascribed to this analysis.

(154) The same kinds of considerations as were discussed for the head wounds case were applicable in assessing the accuracy of the trajectory based on the President's torso wounds. Here the most critical issue was Kennedy's upper torso attitude rather than the orientation of his head. Consequently, different types of problems were encountered.

(155) The Croft photograph, while quite illustrative of Kennedy's posture, lacked two features noted in Zapruder frame 312. Since the torso is flexible, no clear stable relationship could be established between the photographed exterior and the unseen interior. Further, this picture was taken at least 1.5 seconds before Kennedy was wounded. During this interval, he had turned his head about 60° to his right and may have shifted his torso slightly. Thus, errors of 5° may easily be present in this interpretation. Finally, an accurate determination of his back and neck wound locations was impeded both by the extremely inappropriate lighting and composition of the autopsy photographs and by the distortions resulting from the tracheostomy performed at Parkland Memorial Hospital. These latter problems probably contributed little to the uncertainty in trajectory location as compared with the more serious difficulties arising from the poor photographic definition of his posture and position.*

(3) The single-bullet theory trajectory

(156) In order to examine the hypothesis that the bullet responsible for Kennedy's back and neck wounds was also responsible for Connally's wounds, a trajectory was constructed based on Kennedy's exit

*The 5° margin of error resulted in a smaller margin-of-error radius than in the head wound trajectory because in this case the limousine was substantially closer to the Texas School Book Depository. (See fig. II–10, JFK exhibit F–133.)

neck wound and the entrance wound in Connally's back. The hypothesis was to be evaluated by determining whether this trajectory lay close enough to the back-neck trajectory to make it reasonable to conclude that both are consistent with the trajectory of one bullet. Necessarily, the margin of error radius for the Kennedy-Connally trajectory would have to intersect the depository at a point within the 13-foot-radius circle of probable accuracy for the back-neck wound trajectory established earlier. Ideally, of course, the two trajectories would line up precisely, but this standard was considered unrealistically high, because, as with Kennedy, Connally's position at the time of this shot could not be precisely established; moreover, each trajectory was subject to its own sources of error.

(157) In addition to the information that already had been analyzed concerning Kennedy's neck wound, derivation of this trajectory required placement of the location of Connally's entry wound to the back. At the committee's request, Connally agreed to have the position of his back wound redetermined by the Forensic Pathology Panel. His inshoot wound was described as being immediately above his right armpit. This description is essentially consistent with figure II–18. (JFK exhibit F–399.) (*57*)

LOCATION OF INSHOOT WOUND IN BACK OF GOV. CONNALLY

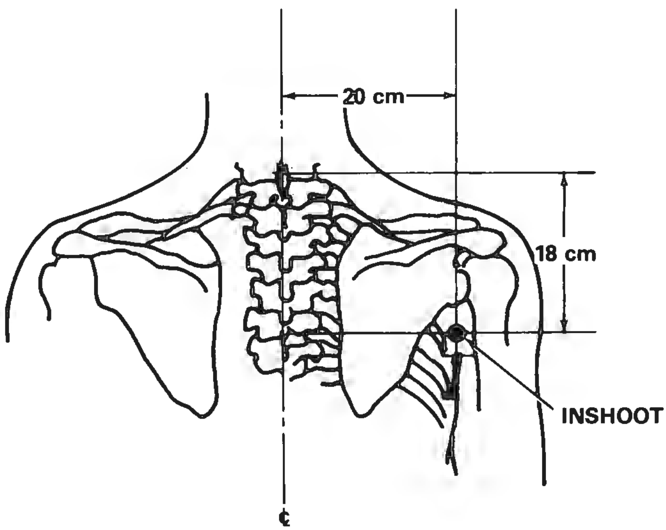


FIGURE II–18

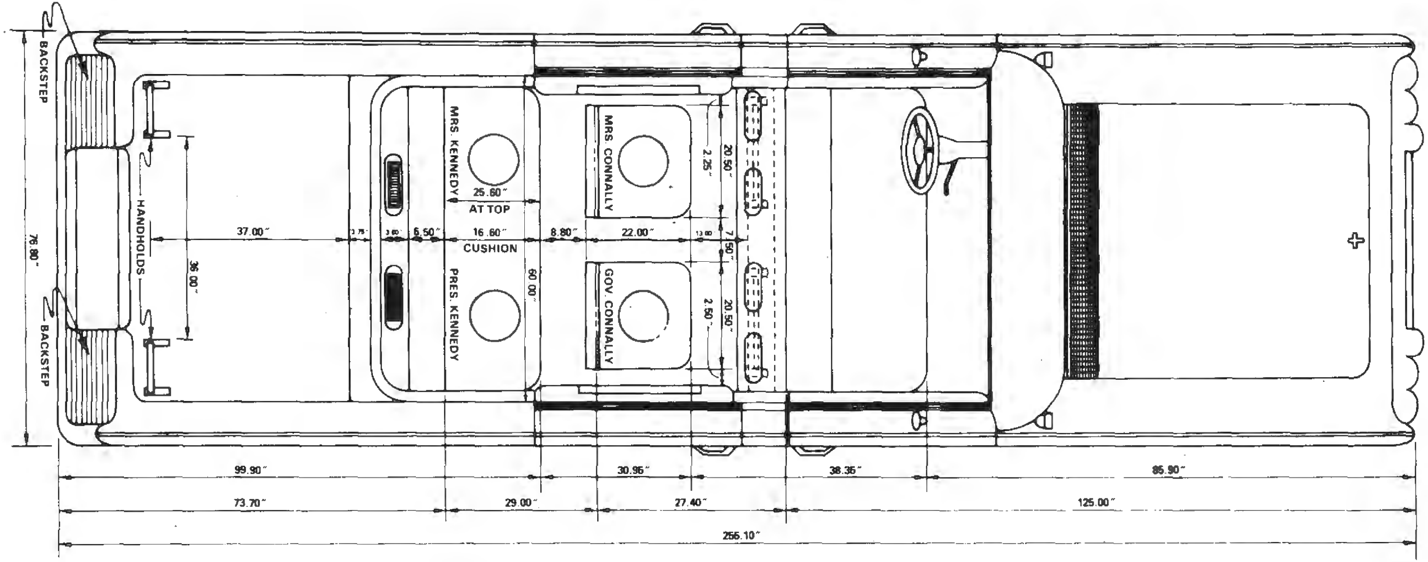
(158) In contrast to the analyses involving Kennedy's wound pairs, the two-man wound combination required focusing on the positions of the two men relative to each other and to their surroundings in Dealey Plaza, rather than just on individual details of posture and orienta-

tion. This analysis was accomplished by reviewing Zapruder frames 180–207, the Croft photograph, and photographs taken by Hugh Betzner and Phillip Willis, two witnesses who were both standing behind and to the left of the Presidential limousine.

(159) Two independent determinations of the lateral relationship between the two men were made. The first consisted of a photogrammetric analysis of several pairs of pictures taken from the Zapruder movie between frames 182 and 200. These pairs were viewed together in a stereoscopic viewer so that together the pairs would project a single, three-dimensional image that could be evaluated for the relative depths of the objects that they portrayed.* The stereo pairs clearly showed that Kennedy was seated close to the right-hand, inside surface of the car, with his arm resting atop the side of the car and his elbow extending, at times, beyond the body of the car. Connally, on the other hand, was seated well within the car on the jump seat ahead of Kennedy; a gap of slightly less than 15 centimeters separated this seat from the car door. (See fig. II–19.) (*58*)

---

*A similar stereophotogrammetric analysis, performed by the Itek Corp. and verified by the photographic evidence panel, indicated that in several stereo pairs Connally was sitting 10.2 to 20.3 centimeters to the left of a line extending straight forward from Kennedy. (See *John Kennedy Assassination Film Analysis*, Itek Corp. (1976), pp. 43–48).



PRESIDENTIAL LIMOUSINE (November 22, 1963)
1961 Lincoln Continental — Modified

Dimensioned from original body draft by
Hess & Eisenhardt Co. of Cincinnati, Ohio

Scale ¾" = 1′-0″

FIGURE II–19

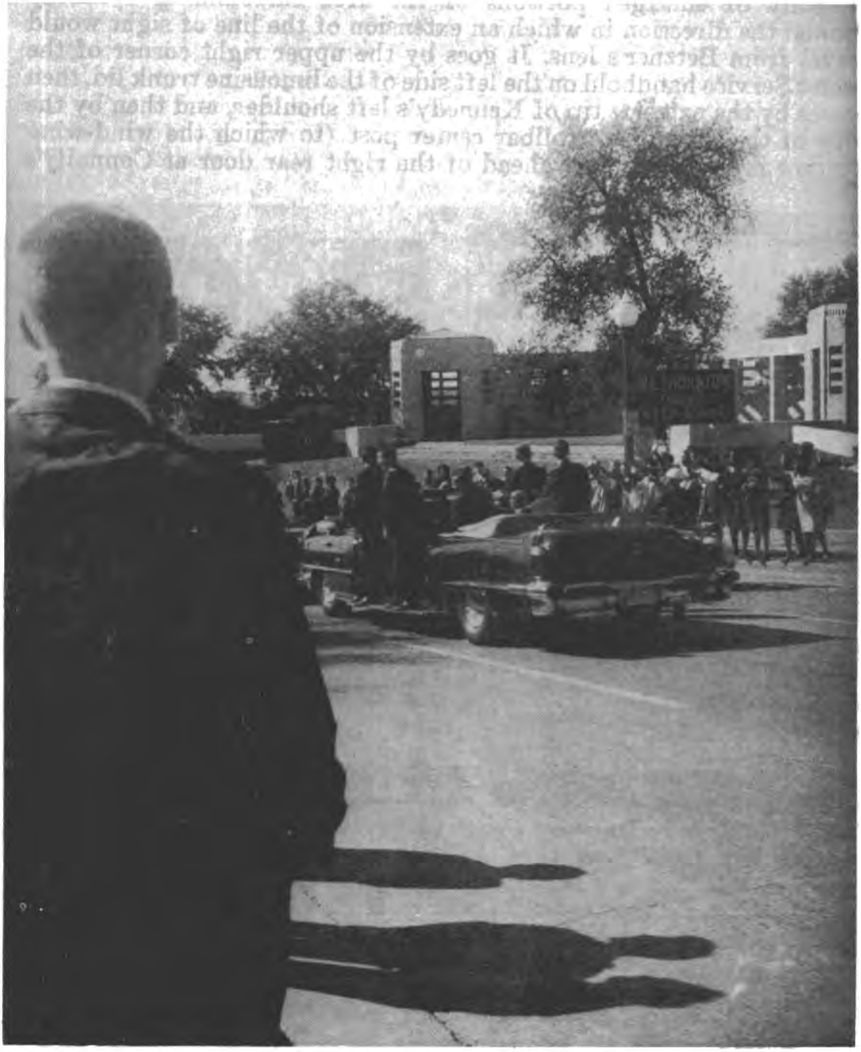


FIGURE II–20

(160) The second photographic analysis, which was based primarily on the Betzner and Croft photographs, confirmed these observations. The Betzner photograph (see fig. II–20) was determined by the panel to have been taken at the time Zapruder frame 186 was exposed.*

*A first generation print of a photograph taken by Hugh Betzner, very close in time and from a similar vantage point as the Willis No. 5 photograph, was examined by the panel; no enhancement processing was performed as the original negative was never located. The Betzner photograph was correlated to the corresponding Zapruder frame by establishing when a Secret Service agent riding in the car behind Kennedy could be seen in both Zapruder's and Betzner's immediate line of sight.

Scrutiny of enlarged portions of the area surrounding Kennedy showed the direction in which an extension of the line of sight would travel from Betzner's lens. It goes by the upper right corner of the Secret Service handhold on the left side of the limousine trunk lid, then passes by the extreme tip of Kennedy's left shoulder, and then by the edge of the limousine's rollbar center post (to which the wind-wing window is attached) just ahead of the right rear door at Connally's

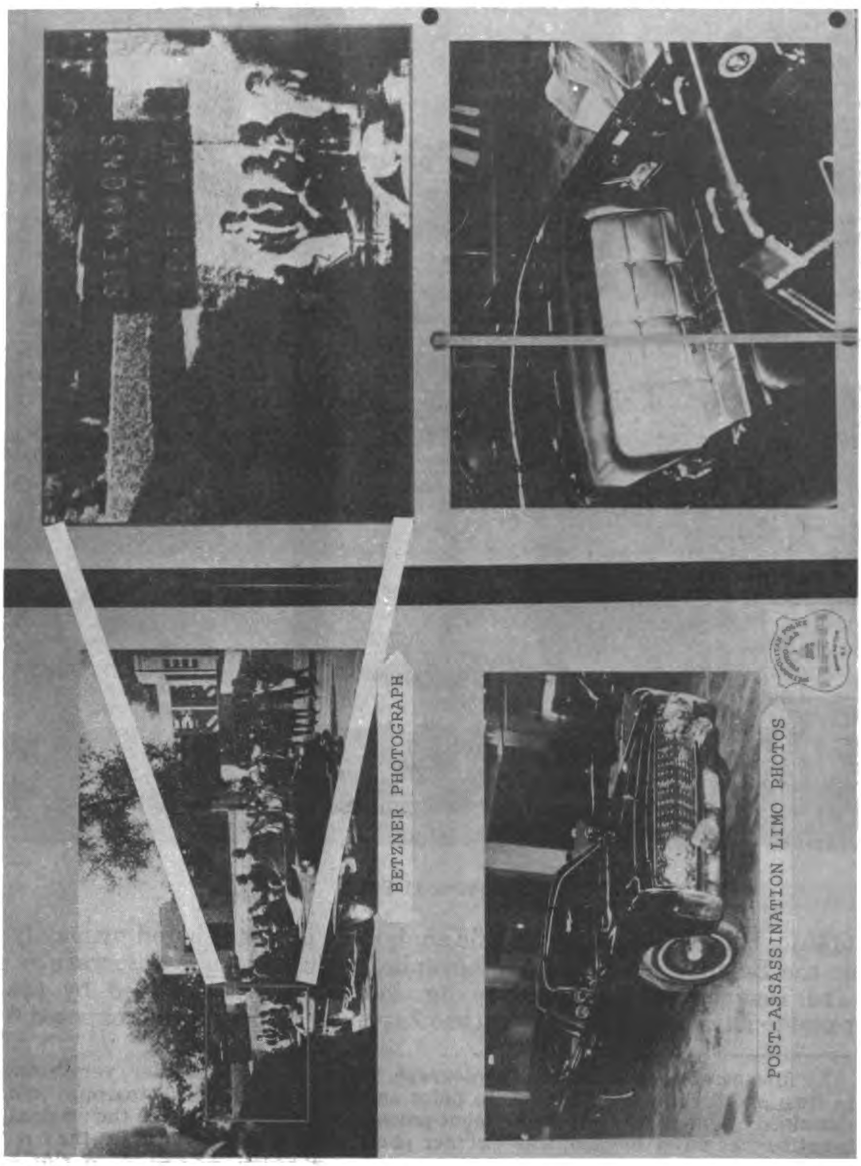


Figure II–21

FIGURE II–22

right.** This line establishes a boundary to the left of which no part of Kennedy can be seen. Nor are there visible signs of Connally's right shoulder or arm slightly to the left of this boundary (the line of sight is limited by the spectator's arm in the foreground). Therefore, Connally must be seated to the left of this line of sight.

(161) With these two observations and some supportive evidence drawn from the remaining pictorial evidence, it was possible to outline Kennedy as he would have been seen from directly above. The key additional features used were his posture and inclination, which were derived from the Croft picture (see fig. II–14), and the slight indication of torso rotation to his right, derived from the Zapruder film. Next, a similar outline was drawn for Connally, with his shoulders against the backrest of the jump seat as far to the right as can be justified in view of the Betzner photograph, and turned to his right.

(162) The direction in which Connally's torso was facing has been determined on the basis of viewing the Zapruder movie and by care-

**Fig. II–21 (JFK exhibit F–136) demonstrates the Betzner photograph line-of-sight analysis. The rollbar center post has a diagonal appearance in the Betzner photograph because it is inclined inward from the side of the car toward the rollbar. See fig. II–22 for a clearer view of the rollbar post, as seen from a similar angle in a photograph taken by James Altgens on Houston St. less than a minute earlier.

ful study of a particularly clear stereo pair taken from the movie. The estimates of the angle of his twist vary from 30° to slightly over 45°. The two outlines show the positions of the men relative to one another. (See fig. II–23.) Connally cannot have been sitting very far to the left of this position in view of his location in Zapruder frame 190. (See JFK exhibit F–226.)

RELATIVE POSITIONS OF PRESIDENT KENNEDY AND GOVERNOR CONNALLY AS DEDUCED FROM PHOTOGRAPHIC EVIDENCE

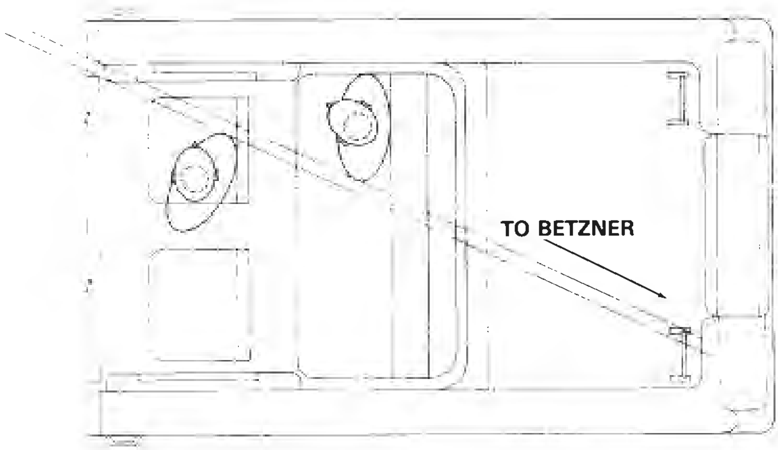


FIGURE II–23

(163) The point-to-point distance between Kennedy's neck and the part of Connally's back that was wounded was determined photogrammetrically in the Croft photograph to be approximately 60 centimeters. The height differential between the two was determined in a similar manner to be 8 centimeters.*

(164) Using the lateral and longitudinal relationships, given the limousine as the frame of reference (see fig. II–23), the direction in which the bullet was found to have been moving from the rear was 12.7° from right to left relative to the midplane of the car. The direction of the trajectory was thereby determined by drawing a line at a 12.7° angle relative to the car and extending it to the rear until it intersected the first building that it encountered—the Book Depository, at a point approximately 2 feet to the west of the southeast corner of the building, using Zapruder frame 190 for the moment of impact. (See fig. II–24.)

*The appearance of an even greater height difference between the two men, as depicted in the Croft photograph, resulted from the more inward position of Connally in the car and the slightly downward line of sight from Croft's camera.

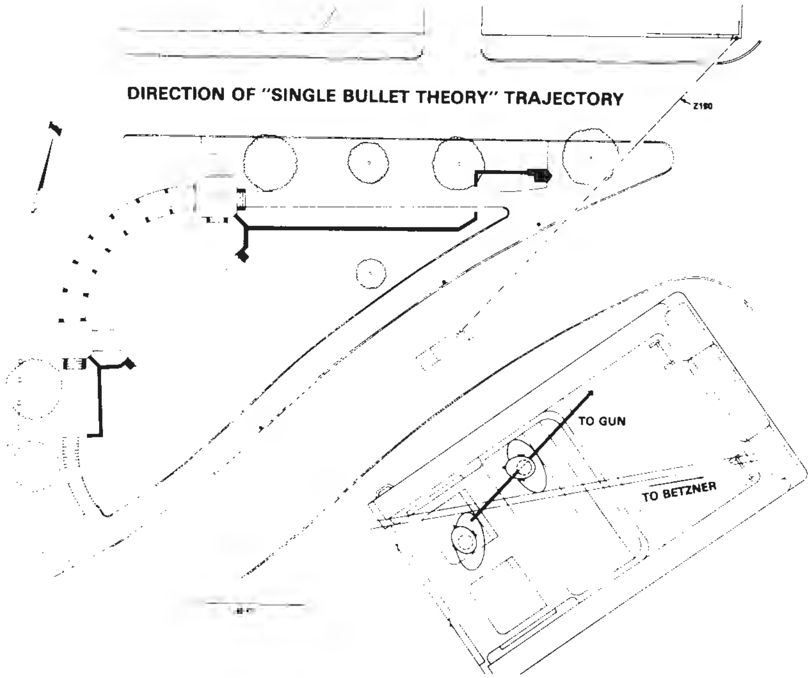


FIGURE II–24

(165) In deriving the slope of the trajectory, the difference in height between the two wounds, the 60-centimeter distance between them, and the inclination of Elm Street, were taken into account. Kennedy's neck wound was 1.1 centimeters below his first thoracic vertebra; his forward inclination lowered the wound an additional 2.4 centimeters. Connally's inshoot wound was 18 centimeters below his first thoracic vertebra. Thus, if the men had been sitting so that the tops of their heads were at equal heights, Kennedy's wound would have been 14.5 centimeters higher than Connally's.* Then, taking into account that Kennedy was seated approximately 8 centimeters higher than Connally (as observed in the Croft photograph), Kennedy's wound is found to have been 22.5 centimeters higher (14.5 plus 8 centimeters) than Connally's relative to the car. This height difference over a distance of 60 centimeters (point-to-point distance between the wounds) yields a downward slope of about 22° from Kennedy's wound to Connally's. Finally, accounting for the 3° slope of the street, the slope of the trajectory is found to be 25°.

(166) This means that the bullet was traveling at an angle of 25° below true horizontal as it passed forward from Kennedy's neck to Connally's back.** Using the position of the men at the time of Zapru-

*This analysis makes the assumption that the distance in each man from the top of his head to his first thoracic vertebra is approximately the same.

**This slope is 2° steeper than described in testimony before the committee on September 12, 1978, because the former was based on a 6-centimeter height difference instead of 8 centimeters, as presently interpreted.

der 190, if this line is extended toward the rear, it intercepts the depository building about 9 feet above the sixth floor windowsill.* (See fig. II–25.)

SLOPE OF "SINGLE BULLET THEORY" TRAJECTORY

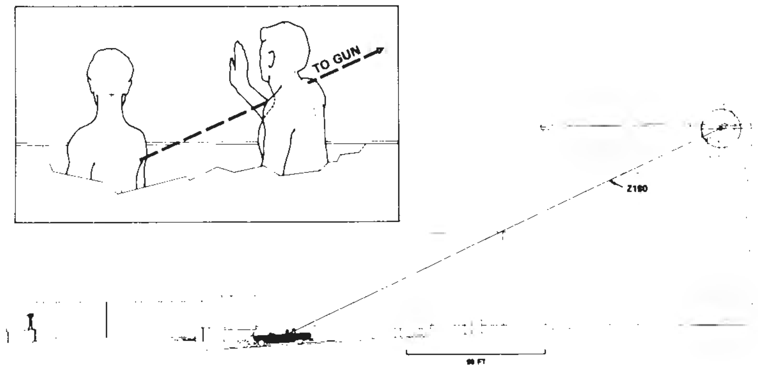


FIGURE II–25

(167) In figure II–25, a circle of 7 feet radius, representing the estimated minimum reasonable margin of error, has been drawn around the intercept point. It is smaller than those of the other two trajectories simply because the distance between the two wounds (60 centimeters) is more than four times as great as that for the back/neck case (14 centimeters) and five times that for the fatal bullet (11 centimeters). This longer baseline distance admits greater error in wound location and body position, while yielding superior accuracy. The eastern border of the error circle is somewhat better fixed than the western because the right-most position of Connally was better defined than the left-most.

(168) The consistency of the single-bullet theory trajectory with the back/neck shot trajectory described earlier is illustrated by their similar direction and slope. Note that the intercept point of the single-bullet theory trajectory at the Texas School Book Depository lies very close to the margin of error circle established for the back-neck case. Indeed, the two error circles overlap substantially. (See figs. II–17 and II–25.) Clearly, this analysis supports the single-bullet theory. The reliability of this trajectory in indicating the position of the gunman would be less if it could be shown that the bullet had been deflected as it passed through Kennedy's tissue. Nevertheless, the evidence indicates that the bullet passed near, but did not strike, the right lateral processes of the seventh cervical and first thoracic vertebrae (nor any other bony matter). (*59*) Consequently, the deflection, if any, was probably negligible.

---

*This result differs somewhat from the testimony given before the committee on September 12, 1978, because the adjustment in the height differential between the two men affected the ultimate determination of trajectory slope.

ADDENDUM A

Calibration Photographs of the Replica of President Kennedy's Head

(169) Photographs of Kennedy taken immediately before each shot provide invaluable, albeit imperfect, records of his position and orientation at the time of the assassination. The quantitative interpretation of these photographs was facilitated through detailed comparisons with calibration photographs taken of a full-scale replica of Kennedy's head, upper torso, and arms.

(170) Calibration photographs may be defined as photographs of a replica that is geometrically and texturally representative of a subject; they are taken under controlled conditions and are used to facilitate quantitative interpretation of photographs of the real subject that were taken under uncontrolled circumstances. Requirements for a good calibration photograph include: accuracy of the replica, photographic distortion similar to that in the real-life photograph under study; comparable positions for the camera and replica; and comparable lighting distribution. The calibration pictures should have somewhat superior photographic qualities in terms of spatial resolution and contrast so that error will not be introduced into the interpretation.

Head replica

(171) To maximize the accuracy of the replica, the Aeromedical Research Institute of the FAA's Aeronautical Center worked with a group of high-quality photographs from the National Archives. Using dimensions obtained from well characterized X-rays of Kennedy's head taken shortly before the assassination, the size and proportions of his skull and the thickness of overlying tisue (front and rear) were established. Modeling clay was applied to a standard plaster skull until the form of his head was duplicated in many aspects. To achieve improved photographic realism, artificial eyes and a wig were added. The head was then mounted on the neck of a standard FAA anthropometric dummy.

Simulation of lighting and environment

(172) A single studio light was used to simulate the Sun, with two small studio floodlamps to augment the illumination by the studio skylight of the figure and the neutral background. At the time of the first shot, Kennedy had been facing west. The spotlight was accordingly positioned to the model's left. It was placed about 36° above horizontal from the head, a position comparable to that of the midday November Sun. Similar lighting was arranged for the head-wound shot. In this case the elevation of the spotlight (Sun) was about 56°, compensating for the erect placement of the head on the dummy, and it was placed nearly straight in front because Kennedy had been facing south.

(173) Camera stations—the various points from which the dummy would be photographed—were marked out on the studio floor in an arc 25 feet from the bridge of the model's nose. Two plumb bobs were suspended beside the figure to provide a precise vertical and angular reference respectively. Beads were installed on each plumbline at a point level with the bridge of the dummy's nose. The elevation of the camera was varied to achieve the desired angles of elevation relative

to the dummy. (This caused the actual distance between the camera and the dummy to change slightly.)

(174) Once the camera stations were established, a series of photographs was taken at varying elevations from each station, with the location of each photograph recorded. The pictures were then compared with an enhanced photograph of Zapruder 312. (See fig. II–8.) The goal was to determine the angular orientation of Kennedy's head relative to his surroundings in Dealey Plaza. Since the positions of the Zapruder and Nix cameras, with which the best pictures had been taken, were known, only the position angles relative to each camera's line of sight and to vertical references visible in the respective pictures had to be found.

(175) The relative positions of the features of Kennedy's head varied with the viewing aspect. In Zapruder frame 312, part of Kennedy's nose was obscured by his right cheek because his head was turned slightly away from the camera. His right ear appears slightly forward of where it would have been had he not been facing slightly away. His cheekbone and ear appear slightly elevated in Zapruder frame 312 as the camera was, in effect, viewing the President from slightly "below" because of the inclination of his head to the left.

(176) All these relationships among features were accounted for simultaneously during comparison with the calibration photographs. Serious impediments to accurate interpretation of the photograph were occasioned by the extremely complicated background to the President's face resulting from Mrs. Kennedy's pink suit and dark blue blouse and by the interior surface of the left side of the limousine. These problems were overcome in part by the use of a computer-enhanced version of Zapruder frame 312. (See fig. II–8.)

ADDENDUM B

Correlating Trajectory to the Acoustics Results: Trajectory of Head-Shot Wounds Based on Zapruder Frame 327

(177) The acoustics analysis indicates that four shots were fired at the Presidential limousine with the first, second, and fourth shots coming from the Texas School Book Depository and the third from the grassy knoll. (*60*) Given these findings, as well as the timing of the shots, approximately 1.6, 6, and 0.7 seconds apart, Zapruder frame 312, which immediately precedes the frame that shows the fatal head shot, theoretically could be the time of impact of either the third or fourth shot of this sequence. (*61*)* If it was the fourth shot, the third shot would have had to impact (if it had hit) approximately at Zapruder frame 296; (*62*) if it was the third, then the fourth shot would have had to impact (if it had hit) approximately at Zapruder frame 327. (*63*)** (See illustration 33a, fig. II–26.)

---

*The first two shots are spaced only 1.6 seconds apart. Consequently neither of these shots could have caused Kennedy's fatal head wound, since it is apparent that at least by Zapruder frame 224, Kennedy and Connally are already reacting to their earlier wounds.

**The correlation between the acoustics tape and the Zapruder film indicate that this shot would have occurred approximately at Zapruder frames 328–329. *See* pars. 108–109 *supra*.

FIGURE II-26

(178) The acoustics, medical, ballistics, and neutron activation analyses, taken together, establish that a shot from the Texas School Book Depository struck the President's head. (*64*) The head shot trajectory analysis based on Kennedy's orientation and location at Zapruder frame 312 assuming this to be the fourth shot fired is consistent with this. Nevertheless, the committee decided to examine the possibility that the fourth shot fired from the Texas School Book Depository impacted at Zapruder frame 327 and that the third shot, fired from the grassy knoll, was therefore responsible for destroying Kennedy's head at frames 312–313.

(179) A trajectory analysis was undertaken based on Kennedy's orientation and location at Zapruder frame 327.* If the trajectory were found to go back to the alleged sniper's window in the Texas School Book Depository, it would not necessarily resolve the question. On the other hand, if it did not go back to that location, the conclusion could be drawn that frame 312 was, in fact, the fatal fourth shot which struck Kennedy's head. This conclusion would have to be drawn because the medical, ballistics, and neutron activation analyses, taken together, indicate that the bullet which struck Kennedy's head was fired from the Texas School Book Depository. If the trajectory analysis indicates that this particular bullet could not have impacted at Zapruder frame 327, then the shot must have occurred at Zapruder frame 312, as the trajectory analysis for that frame (described above) does point in the vicinity of the sixth floor window.

*At the time that this trajectory analysis was undertaken, the preliminary correlation of the fourth shot (based on a third shot at approximately frame 312) was at Zapruder frame 327. Frame 327 was exposed less than 1/18 of a second before frame 328. Kennedy's position did not change noticeably during this interval. Therefore, any difference in resulting trajectory would not be significant.

42-370 O - 79 - 5

(180) While precisely the same analytic techniques were employed as those used earlier for the head wounds at Zapruder frame 312, various factors made the results here less precise. Even though the key photograph, Zapruder frame 327, was unenhanced, it nevertheless had good color rendition. The aspect from which Kennedy's head was viewed in this frame, however, did not permit as accurate a determination by comparison with calibration photographs as was the case with Zapruder frame 312.

(181) Little of Kennedy's face was visible, and his right ear was not distinct. In addition, the angle between the direction in which Kennedy's head was "looking" and the line between him and Zapruder's camera could, at best, only be defined plus or minus 5°. The apparent height of the camera relative to Kennedy's facial axis reference was even more poorly defined because of the absence of good visual reference points.

(182) Best estimates of these two angles, as well as an educated judgment of the degree to which Kennedy's facial axis appeared to be tilted left or right relative to level in the Zapruder frame, were achieved after careful study and comparison of calibration photographs approximating Zapruder frame 327. These angular relationships, plus the position estimated for the limousine at Zapruder frame 327 (based on an extrapolation of data on its earlier position) were then used to orient Kennedy's head relative to the surroundings in Dealey Plaza. Completing the analysis required construction of the line through the wound locations as before and extending the line toward the rear. When plotted, the line intercepts the face of the Texas School Book Depository about three-fourths of the building's length to the west of the southeast corner. (See fig. II–27.) When the slope of the line is derived as before, the line then intercepts the building's vertical plane just above the roof of the building. (See fig. II–28.)

LINE OF SIGHT FROM ZAPRUDER CAMERA TO JFK/DIRECTION OF BULLET CAUSING HEAD WOUND

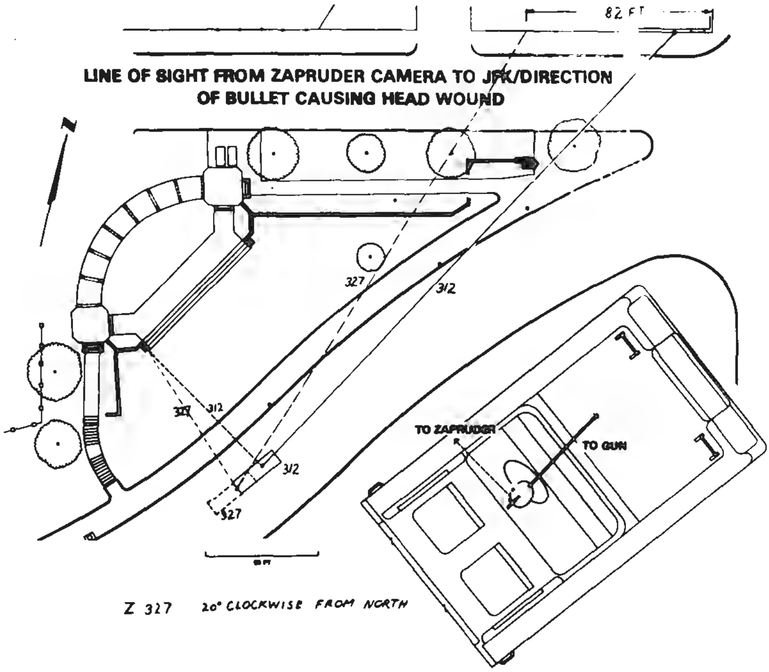


FIGURE II–27

LINE OF SIGHT FROM ZAPRUDER CAMERA TO JFK/SLOPE OF BULLET CAUSING HEAD WOUND

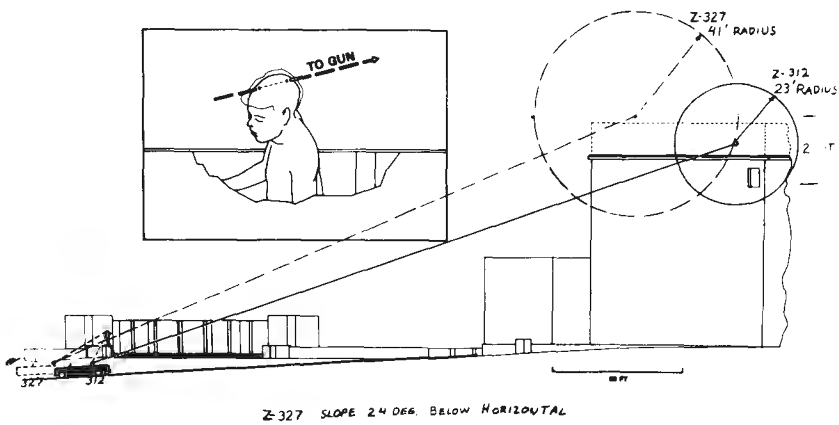


FIGURE II–28

(183) A step-by-step examination of potential errors suggests that this trajectory is subject to approximately twice the error estimated for the head shot trajectory for Zapruder frame 312 because the photographic aspect was so much more difficult and the photographic quality slightly inferior in frame 327.
(184) Despite the problems, this analysis was sufficiently precise to establish that the firing point for a Zapruder frame 327 head shot trajectory is highly inconsistent with either that of the Kennedy back-neck or the single bullet theory trajectories. The latter two are quite consistent with an origin in the southeast sixth floor window of the Texas School Book Depository, whereas, even with a 46-foot estimated minimum reasonable margin of error radius, the head trajectory for Zapruder frame 327 does not take in the alleged sniper's window. For this reason, it is highly unlikely that the head wounds were inflicted by firing a bullet from the southeast window that impacted at the time of Zapruder frame 327.
(185) Once Zapruder frame 327 has been eliminated as a possible fourth shot fired from this window, the conclusion must be made that this fourth shot must have occurred at Zapruder frame 312.

5. PHOTOGRAPHIC EVIDENCE OF DEALEY PLAZA

[See pars. 241–346 infra.]

III. The Assassin

A. The Alleged Assassination Weapon*

1. INTRODUCTION

(186) The Warren Commission concluded that CE 139, a Mannlicher-Carcano rifle, was used to assassinate President Kennedy. (*65*) This rifle was linked by the Commission to Lee Harvey Oswald by both fingerprint and cloth fiber analysis, and by two photographs taken in Oswald's backyard that depict him holding the weapon. (*66*) These findings, however, have been questioned on the basis of observations relative to postassassination photographs of the alleged murder weapon.

(187) It has been observed that when various postassassination photographs of the rifle are enlarged, so that the images of the rifle are the same length, the respective images do not coincide. One picture may show the rifle as having a longer barrel and shorter stock than another photograph, and frequently the component parts do not aline. (*67*) The Photographic Evidence Panel was asked to address this issue and to attempt to determine whether CE 139 could be photographically linked to Lee Harvey Oswald.

2. ISSUES

(188) *a.* Are the dimensions of CE 139, the alleged murder weapon that is in the National Archives, consistent with the dimensions of the rifle that Oswald is shown holding in the backyard pictures and with the alleged murder weapon, purportedly seized by the Dallas Police Department after the assassination, that is shown in numerous postassassination photographs?

(189) *b.* Can CE 139 be established to be both the same weapon that Oswald is shown holding in the backyard pictures and that was the subject of numerous postassassination photographs?

3. MATERIALS AND PROCEDURES

(190) The Photographic Evidence Panel reviewed the analysis that asserted that the relative dimensions of the rifle(s) depicted in these photographs were inconsistent, and perceived immediately that this analysis failed to consider the effect of perspective on the manner in which an image is depicted in a photograph. The camera lens projects an image of the three-dimensional world onto a two-dimensional film plane. This projection usually causes parallel lines in space to be

---

* This section was prepared under the direction of C. S. McCamy and Cecil W. Kirk; technical appendices by McCamy and Kirk are included. For related public hearing testimony, Sept. 14–15, 1978, see HSCA–JFK Hearings, vol. II, pp. 349, 397.

imaged as converging lines, and causes equally spaced intervals on a line that recedes from the camera to be imaged progressively shorter along the receding line.

(191) When a long object, such as a rifle, is tilted toward the camera axis so that one end is farther away than the other, the nearer parts are imaged larger relative to the central parts and the more distant parts are imaged smaller. The degree of difference depends on the angle of tilt. This effect is illustrated in figure III–1. (JFK exhibit F–389). Where the rifle is represented by a straight line and the camera is represented by the two essential parts, the lens and the film. Point A is at one end of the rifle, point B is at the center, and point C is at the other end. The size of the image can be found by assuming that light passes straight through the center of the lens. (*68*) Light from A goes to A′, from B to B′, and from C to C′. Figure III–1 demonstrates that although the length from A to B equals the length from B to C, the length from A′ to B′ is less than half the distance from B′ to C′. The photographic effect of tilt attributable to perspective is further demonstrated by figure III–2 (JFK exhibit F–207.) where five photographs of one particular rifle depict its relative dimensions differently, depending on the manner in which the weapon was tilted.

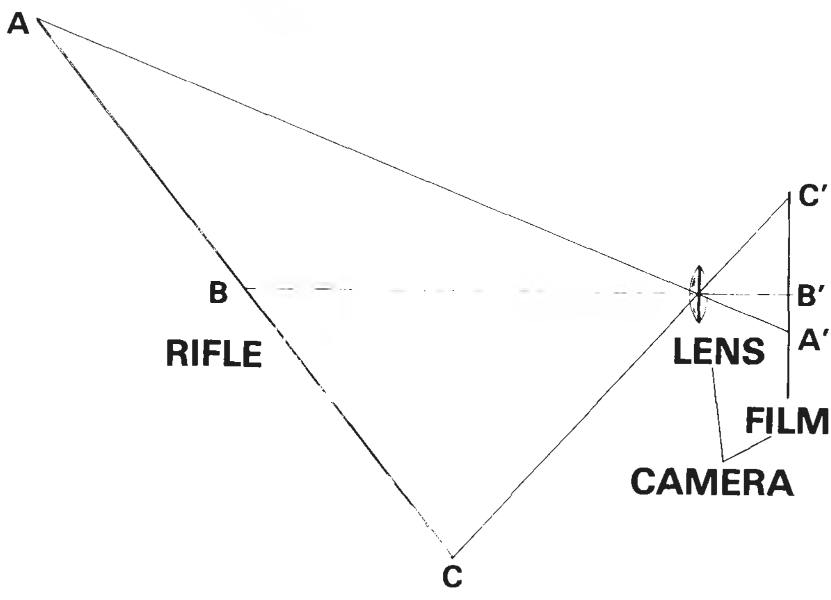


FIGURE III–1.—Photographic effect of rifle tilt.

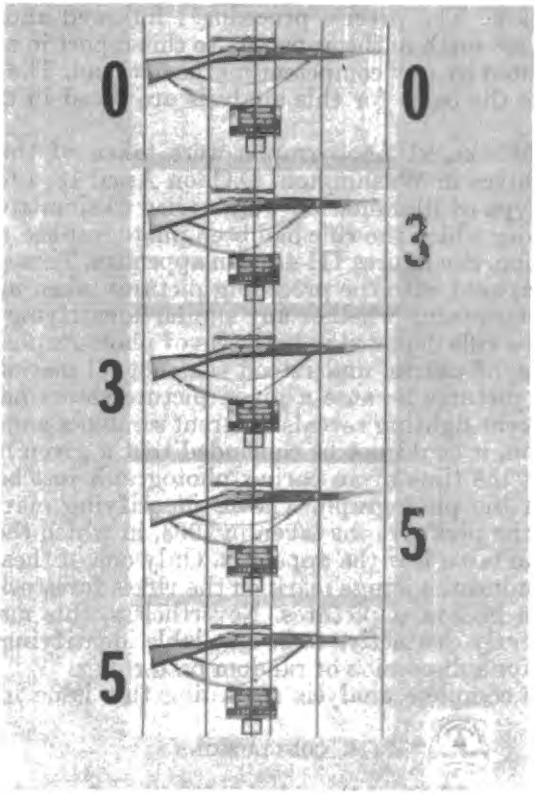


FIGURE III-2.—Effect of rifle tilt on apparent length.

(192) Realizing that the failure to consider the effect of tilt was probably responsible for the observed discrepancies, the Photographic Evidence Panel conducted a study that took the tilt factor into account. In this study the tilt angle, distance from rifle to lens and distance from lens to film* were found that would bring the images of the two ends of the rifle and the rear flat of the rear sight into conformance with the proportions of the Archives rifle. Then, using the same constants, the locations of 10 other points on the rifle were computed from distances measured on the photographs. The two end points of the rifle and the rear sight served as anchor points for the calculation, and consequently were not regarded as measured values. Ten other points were measured for each of 12 photographs on which the points were visible. The mean value was computed for each point. The average deviation of the values from the mean of each point was computed, and the deviation of the mean value from the value for the Archives rifle was computed.

(193) When the tilt was thus taken into account, the proportions of all the rifles photographed matched the proportions of CE 139

*These factors provided the mathematical basis for photogrammetric computations that brought these photographic images of the rifle into proportional conformance with the Archives rifle.

remarkably close. The precise procedures followed and calculations employed are set forth in the appendix to this report in a manner that can be duplicated by any competent mathematician. The photographs that served as the basis for this analysis are listed in table 1 of the appendix.

(194) In addition, 21 photographs were taken of the rifle in the National Archives in Washington, D.C. on April 18, 1978. The point of view and type of illumination were varied to simulate some of the conditions under which the rifle had been photographed at the time of the assassination. See figures III 4a–u in appendix. These photographs were then compared with the preceding pictures taken in 1963 for the purpose of determining whether any similar identifying marks could be found on the rifle depicted in both sets of photographs.

(195) It was, of course, understood that not all marks would show on all of the pictures because a given picture shows only one view. Further, different lighting reveals different scratches and other marks. For this reason, it could not be concluded that a given mark was not on the rifle at the time of an earlier photograph just because it was not visible on the photograph. The 22 identifying marks that were detected and the photographs taken in 1963, in which they are shown are set forth in table 7 of the appendix. Only one of these, the largest and most prominent, a gouge mark on the rifle's forestock, was visible on any of the backyard pictures. Nevertheless, this mark was considered sufficiently distinctive to be a reliable identifying feature. See addendum D for a discussion of random patterning.

The panel's complete analysis regarding this issue is set forth in the appendix.

4. CONCLUSIONS

(196) *a.* A comparison of the relative lengths of parts of the alleged assassination rifle that is in the National Archives with corresponding parts of what purports to be that rifle as shown in various photographs taken in 1963 indicates that the dimensions of the rifle(s) depicted are entirely consistent. *b.* A comparison of identifying marks that exist on the rifle as shown in photographs today with marks shown on the rifle in photographs taken in 1963 indicates both that the rifle in the Archives is the same weapon that Oswald is shown holding in the backyard picture and the same weapon, found by Dallas police, that appears in various postassassination photographs.

ADDENDUM

REPORT ON AN EXAMINATION OF PHOTOGRAPHS OF THE RIFLE ASSOCIATED WITH THE ASSASSINATION OF PRESIDENT JOHN F. KENNEDY *

Introduction

(197) The alleged assassination weapon was the subject of many photographs. An hour or so after President Kennedy was shot and killed on November 22, 1963, the Dallas police found a rifle in the Texas School Book Depository.(*69*) The police photographed the rifle where it was found. During the search of the building, a 16-millimeter motion picture was taken by Thomas Alyea of television station

---

*This section was prepared under the direction of C. S. McCamy.

WFAA. This motion picture film depicts the rifle at the time that it was discovered by the police.(*70*) A police officer carried the rifle from the building and, as he walked east on Elm Street and across Houston Street, reporter Allen, of the Dallas Times Herald, took a series of about seven pictures in rapid succession.(*71*) As the rifle was carried through the halls of the police station, it was held overhead for reporters to see. Numerous photographs were taken at that time. During the investigation, both the Dallas police and the FBI photographed the rifle a number of times in their photography labs.(*72*)

(198) Among Oswald's personal effects, the police found photographs depicting Oswald standing in his backyard, holding a rifle that looked like the rifle found in the book depository. These photographs were among the evidence considered by the Warren Commission. (*73*)

(199) Since that time, a number of authors have reexamined the evidence and raised questions about the conclusions drawn by the Warren Commission. It has been observed that when some of these photographs are enlarged so that the various images of the rifle are the same length, the images do not coincide. The proportions of the lengths of images of component parts of the rifle do not match. See fig. III-5 (JFK F-208) [White exhibit]. One picture may show the rifle as having a longer barrel and shorter stock than another picture, or different components of the rifle simply do not align.(*74*)

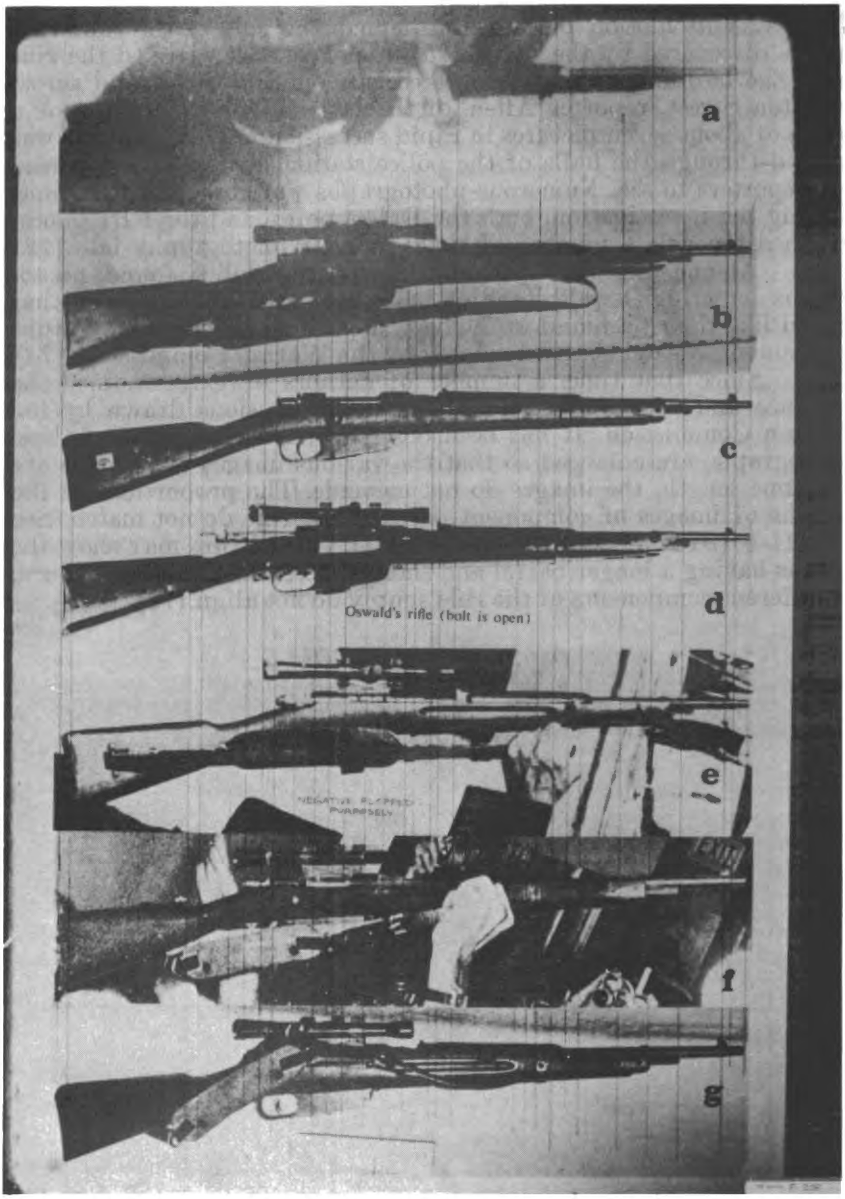


FIGURE III-5.—White Testimony Exhibit.

(200) Early in 1978, at the request of the committee, photographic panel member C. S. McCamy, undertook a study of this evidence. He studied two aspects of the evidence: (1) A comparison of the relative lengths of parts of the rifle, shown in various photographs taken in 1963, to the corresponding dimensions of the rifle now in the National Archives in Washington, D.C.; and (2) a comparison of identifying

marks shown on the photographs taken in 1963 with those shown on photographs he made of the rifle now in the National Archives. Both lines of investigation revealed facts that support the conclusion that the same rifle is depicted in all of the pictures examined. The study of proportions offers strong evidence that the rifle (or rifles) photographed is (or are) of the same kind. The comparison of identifying marks offers strong evidence that only one rifle is involved. The claims of gross mismatch are clearly refuted.

Relative Length Comparisons

(201) The artist knows that parallel lines in three-dimensional space must be depicted as converging lines on a two-dimensional representation, and that equally spaced intervals on a line must be depicted as progressively closer as the line recedes from the viewer. This kind of rendering is automatically performed by the camera lens. Nevertheless, the human visual system, involving both the eye and brain, interprets photographs as though they were objects in three-dimensional space. We rarely notice the rendering of perspective in pictures, as long as the pictures look natural.

(202) The various pictures of the rifle were taken at various angles. Viewed naturally, normal perspective causes parts of an object tilted towards the camera to appear lengthened relative to those parts that recede from the camera. See figure III-1 (JFK F-389) (rifle tilt). The extent to which this phenomenon occurs is a function of the degree to which the object, here a rifle, is tilted relative to the camera. Accordingly, in order to make a valid study of an object's relative length as depicted in photographs, the tilt factor attributable to perspective must be taken into consideration. This can be done using the same type of analysis that is employed in the making of maps.

(203) Most maps are now made by transferring measurements from aerial photographs. If the camera carried by the airplane is tilted with respect to the vertical direction, the effect of perspective must be taken into account. Thus, the matter dealt with here is an everyday problem, well understood by those who practice photogrammetry, the science of using photography to measure dimensions. (*75*)

(204) It would have been possible to have these measurement studies done by highly automated methods in a mapping agency of the U.S. Government, but to achieve the highest degree of acceptance and popular understanding of the methods, special simplified forms of photogrammetric equations were derived and are set forth in addendum A. All measurements on photographs were made with an ordinary millimeter scale and hand magnifier, and all calculations were performed with a commonly available pocket calculator having a memory and trigonometric functions. These mathematical derivations can be followed by a typical high school mathematics teacher, and all of the operations can be repeated by anyone with adequate patience and the intelligence to do calculations. The procedures are admittedly very laborious.

(205) The photographs that were the subject of this analysis are listed in table No. 1. With the exception of the picture taken by the Federal Bureau of Investigation, these pictures are enlarged prints of small negatives. The enlargement ratio or magnification of the enlarger M is the ratio of the length x' of an image on the enlarged pic-

ture to the length x of the corresponding image on the negative: $M=x'/x$. From this it follows that a distance on the negative x can be computed from the corresponding distance x' measured on the enlarged print and the magnification M by the following formula:

$$x=x'/M$$

The magnification of a contact print is 1.

(206) Since the objective is to compare lengths along the bore of the rifle or lines parallel to it, it is possible to work with the simple equation for computing distances along a straight line, rather than the more general three-dimensional photogrammetric equations. In practically all cases, the line of the rifle image passes nearly through the center of the picture and almost always the rear sight is near the center. Thus figure 6 is fairly representative. The derived equations also are valid if the rifle image is displaced from this central position. In that case, the image distance derived would not be the axial image distance,* [(3)] but the distance from the image of the rear sight to the rear nodal point * [(2)] of the lens. The computed proportions of the rifle would not be affected.

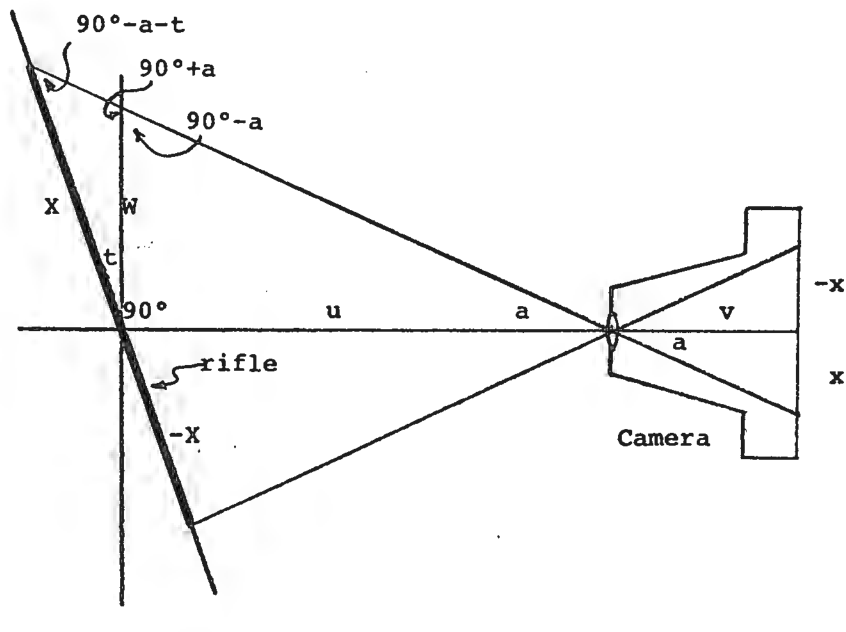


FIGURE III–6.—Geometric relationship of camera to the rifle titled at an angle t.

(207) As shown by the equations set forth in addendum A, when one point of an object is imaged at the center of a photograph, the actual distance X between that point and another point on the object may be calculated by measuring the corresponding distance x between

*These technical terms may be defined as follows:

[(1)] The optical axis is the line joining the center of the lens and the center of the image area.

these points on the photograph itself. This may be accomplished if we know the angle of title t between the linear object and a plane normal to the optical axis * [(1)] of the camera lens, the distance u from the center of the object to the front nodal point* [(2)] of the lens, the axial image distance v, and the distance from the rear nodal point of the lens to the camera image. The equation is:

$$X = \frac{ux}{v \cos t - x \sin t}$$

If we know u and the focal length* [(4)] of the lens, we can compute v, using the following equation:

$$v = uf/(u-f)$$

(208) In the present case, neither the distance u from the rifle to the camera lens, nor the angle of tilt t, nor the axial image distance v, is usually known. Most of the information needed to compute a distance X on the photographed rifle from a distance x on the negative is lacking. Nevertheless, the objective is not to compute such lengths; rather, it is to compare relative proportions of the parts of rifles photographed with the proportions of parts of the rifle in the Archives. To accomplish this, it is only necessary to scale the length of each rifle photographed to the length of the rifle in the Archives. The tilt angle t that makes the ratio of the length from the rear sight to muzzle and the length from rear sight to butt is the same as the corresponding ratio on the Archives rifle.* The tilt angle t is found by the following equation, which is based on the scaling described:

$$\tan t = \left(\frac{X_2}{x_2} - \frac{X_1}{x_1} \right) \frac{v}{X_2 - X_1}$$

where: t is the tilt angle

X_2 is the length on the Archives rifle from rear sight to one end,
x_2 is the length on the negative image from rear sight to one end,
X_1 is the length on the Archives rifle from rear sight to the other end,
x_1 is the length on the negative image from rear sight to the other end,
and v is the axial image distance (lens to film)

The subscript 1 is assigned to the distance corresponding to the end of the rifle tilted away from the camera, and 2 is for the end tilted toward the camera. All measurements were from the vertical plane of the rear sight.

---

(2) The front nodal point is the point of view from which the scene is imaged by the camera. The rear nodal point of the lens is the corresponding point in image space. The ray of light from the rear nodal point of the lens to an image point is parallel to the ray from the corresponding object point to the front nodal point of the lens.

(3) The axial image distance is the distance along the optical axis from the rear nodal point of the lens to the center of the image area.

(4) The focal length is the axial image distance when the camera is focused on an infinitely distant object.

*It may be mistakenly argued that this analysis seems to take for granted that to be proven because the angle that is found makes the 2 ends and the middle of the rifle image correspond to the proportions of the rifle in the Archives. Nevertheless, once the angle of tilt and the distances are found, 10 other distances are computed using the same equation. The degree to which these 10 distances correspond to distances on the Archives rifle is the basis for determining whether the rifle photographed has the same proportions as the Archives rifle.

(209) As one looks at a photograph, depending on the degree of tilt, it may or may not be obvious whether the muzzle was tilted away from the camera or toward it. There is a mathematical test that can be applied to the measurements on the photograph to determine which way the muzzle was titled, assuming that the photographed rifle does, in fact, have the same proportions as the Archives rifle. The sight-to-muzzle length divided by the sight-to-butt length of the rifle in the Archives is 465.8/553.0. If the corresponding ratio for lengths measured on the photograph is less than this number, the muzzle was foreshortened because it was tilted away from the camera. If the ratio is greater, the muzzle was tilted toward the camera.

(210) For the sake of convention, each measurement of sight-to-muzzle and sight-to-butt length was assigned a positive or negative number, depending upon which way these respective parts were tilted in relation to the camera. The respective part tilted away from the camera was assigned the positive number and the respective part tilted toward the camera was assigned the negative number. See table 3.

(211) If the tilt angle t, the axial image distance v, the length X_1, on the Archives rifle, and x_1 on the photographic negative are known, it is possible to compute the distance u from the center of the object (the rear sight of the rifle photographed) to the camera lens:

$$u=\frac{X_1}{x_1}(v \cos t = x_1 \sin t)$$

(212) Given these five relationships, the following sequence of operations were used to compare a photographed rifle with the rifle in the Archives. The lengths of many parts of the rifle in the Archives were measured. The points to which measurements were made are named in table 2 and the measured distances are given in the first column of table 5. All lengths were measured along lines parallel to the bore. The corresponding lengths were measured on a photograph. Twelve photographs, representative of all the photographs examined (see table 1) were selected for measurement. These measurements are given in table 3.

(213) When the negatives were available, as was the case for photographs by William Allen, Dallas Police (one instance), and McCamy, the enlarged magnification was computed from material deleted, see text measurement of the distance between frame borders depicted on the enlargement and measurement of the actual distance between frame borders by the Geological Survey. In all other cases, magnification was estimated.*

(214) The focal lengths of camera lenses were known for the backyard photograph (calibrated by the Geological Survey; see Addendum B), McCamy's photograph (calibrated by McCamy), and the Dallas

*Magnification, focal length, and object distance were estimated by knowing or assuming the size camera used and by visual inspection of the given print. These first estimates provided a starting point for the computations. A series of computations refined the estimates until a consistent set of values was found. If the assumed camera size were erroneous, the assumed magnification would be wrong and the axial image distance computed would be off by the same factor. These effects would cancel, so the erroneous estimates would not affect the determination of the proportions of the rifle. It would be immaterial whether we were measuring a 2x enlargement of a negative 4 inches wide or an 8x enlargement of a negative 1 inch wide.

Police laboratory photographs (nominal focal length supplied by Dallas Police).(*76*) Other focal lengths were estimated by taking into account common practice at the time the photographs were made. The object distance u was measured for the McCamy photograph. In all other cases, it was estimated.

Sequence of Computations

(215) 1. Based on known or estimated object distance and focal length, the first estimate of axial image distance v was computed by the second equation in paragraph 207.

2. Based on known or estimated magnification, negative image lengths x were computed from measured corresponding lengths x' on enlargements by the last equation in paragraph 205.

3. A first estimate of tilt angle t was computed by the equation in paragraph 208.

4. A second estimate of object distance u was computed by the equation in paragraph 211, based on the first estimates of v and t.

5. A second estimate of axial image distance v was computed by the second equation in paragraph 207, based on the second estimate of u.

6. A second estimate of t was computed based on the second estimate of v.

7. A third estimate of u was computed based on the second estimates of v and t.

8. The computations were done repeatedly, each time using the last computed estimates of t, u, and v. From one computation to the next, the successive approximations changed less each time until, finally, no appreciable change was found from one computation to the next. This determined the set of values of u, v, and t that scaled the two main parts of the photographed rifle to the Archives rifle and took into account the tilt angle.

(216) Given u, v, and t, the first equation in paragraph 207 was used to compute the lengths X of various parts of the rifle as deduced from the lengths x of corresponding parts on the negative image. The computed lengths X of the parts of the rifle could then be compared directly to measured lengths of parts of the Archives rifle. If the lengths of various parts of a photographed rifle were proportional to corresponding parts on the Archives rifle, the lengths computed by this procedure would match the lengths measured on the Archives rifle.

(217) In performing these calculations, the same scale for all measurements was used. It was uncalibrated except that the centimeter divisions were checked for consistency. The rifle was measured with an uncalibrated steel metric tape.

(218) The results of these calculations are set forth in tables 4 and 5. In each instance, the relative lengths of the corresponding measured parts were found to be proportional, and the resulting computed lengths matched very closely. In performing the computations, it is important to bear in mind the sign of X and x. They are negative when referring to the part of the rifle tilted toward the camera. In particular, the second term in the denominator of the first equation in paragraph 207 is a negative quantity toward one end of the rifle and positive toward the other.

(219) The two endpoints of the rifle and the rear sight are anchor points for the analysis, so they should not be regarded as measured

values. Each of 10 other points was measured by the technique given for all of the 12 photographs on which the points were visible. The mean value was computed for each point. The average deviation of the values from the mean of each point was computed. The deviation of the mean value from the value for the Archives rifle was computed. All of the data are given in table 5.

(220) The computed distances were within 3 or 4 millimeters of the corresponding distances on the rifle in the Archives; this reflects an approximate error of 1 percent between the actual lengths on the rifle and the lengths computed from the photographs. A comparison of tables 3 and 5 shows that the computed distances involved multiplication factors ranging from 4 to 17 times the distances measured on the photographs. Thus, the errors of measurement were magnified by these amounts. Since measurement errors of a small fraction of a millimeter should be expected, such errors would reasonably account for the deviations from the Archives rifle.

(221) The agreement of the data clearly contradicts the claims of gross discrepancies in proportions of the rifles photographed and offers strong evidence that the rifle or rifles photographed had the same proportions, within reasonably expected experimental error. The only way that there could have been a rifle depicted in these photographs with proportions substantially different from those of the Archives rifle, and yet matched when mathematically oriented at the computed angle t and distance u, would have been if someone deliberately manufactured a special rifle with all dimensions distorted in precisely the right way to appear to match when viewed at some angle other than t. In that case, it would have been necessary to align this specially contrived rifle and the camera very meticulously at the time the pictures were made. It is highly unlikely that anyone could have perpetrated such a ruse without detection in front of the Book Depository or in the halls of the Dallas Police Station a few hours after the assassination of the President. Aside from this possibility, the method used would show close agreement only if the photographed rifle had the same proportions as the Archives rifle, within reasonably expected experimental error, and, of course, this is not what has been claimed by Warren Commission critics. *(77)*

(222) In making the measurements, it is necessary to give some attention to perspective. The simple equations refer to a line, that is, the centerline of the bore of the rifle. They also apply to nearby lines parallel to that line. Nevertheless, if the rifle is tilted and twisted about the centerline, as shown in figure 7, the twist throws the image of the butt to the right. In making the measurements, this must be judged and the line drawn from the butt to the centerline must be angled in keeping with the perspective; this means that the solid line in figure 7, rather than the dotted line which is perpendicular to the centerline, must be used. This comes quite naturally if we let our visual sense guide us. (Notice that even in the crude drawing of fig. 7, the dotted line does not appear to be perpendicular to the centerline. This is an optical illusion. If the perspective is sensed, the solid line appears to be more nearly perpendicular.) High precision requires this technique to be used for all measurements when the endpoints are not the same distance and direction from the centerline. The case illustrated in figure 7 is an exaggeration of photograph 11 (see table 1), where the form of the butt provides a clear indication of the perspective angle.

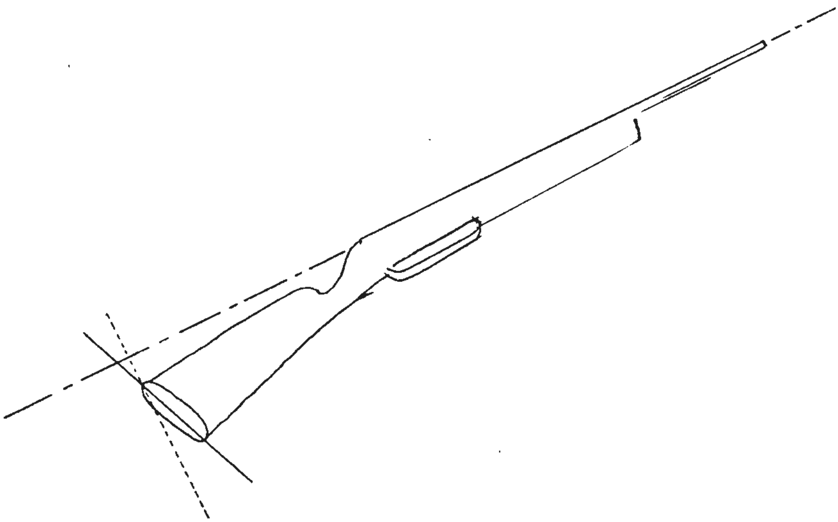


FIGURE III-7.—Taking perspective into account in measuring distances of points off the centerline of the rifle bore, such as the butt, comb, trigger, and trigger guard.

(223) The backyard photograph presented some special problems. The hand obscures the exact location of the rear sight. (See fig. III-3a.) A nearby groove on the outside of the chamber was visible and the rear sight was located relative to this groove. The rear sight was not centered in the photograph but the rear end of the bolt was. The analysis was done relative to the rear end of the bolt and the lengths were then translated to be zero at the rear sight for comparison with the Archives rifle.

(224) Vertical lines near the edge of the picture bow out very appreciably at top and bottom. This is known as "distortion." The distortion of the lens said to have been used to take this picture was measured by the Geological Survey. The image lies along the diagonals designated 90° and 270° by the Geological Survey. The reported distortion along this axis was plotted and appropriate distortion corrections were interpolated on this plot. The distortion correction was 0.2 mm for points 6 and 7. It was negligible for all other points. Since the distortion was positive, these amounts were subtracted from distances computed for the original negative image from measurements on the enlargement. No distortion corrections were made for other photographs or for the enlarging lenses because no distortion information about the cameras that were used to take these photographs was available. Nevertheless, since the photographs other than the backyard photograph were professionally made, the lenses probably had very small distortion.

(225) In addition to the photographs of this rifle, a photograph made by the Metropolitan Police Department of Washington, D.C., of a different specimen of the same kind of rifle was examined and analyzed for the purpose of determining whether the relative properties of Mannlicher-Carcano rifles are necessarily identical. See figure III-8,

No. 4 and No. 5. (JFK exhibit F–206) The data are shown in the tables for picture No. 21.

(226) The metal parts coincide very well except for the rear of the bolt. In this photograph only, the bolt appears to be in the firing position. In all other photographs, it is in the cocked position. This being the case, such a discrepancy should be expected. The only point of comparison of the wooden stocks is the comb, and the computed distance to the comb on this extra specimen is outside the range of computed values of this distance on all the photographs of the Archives specimen. This suggests that there were small differences in manufacturing the wooden parts. This is borne out by the further observation that two angles on the butts are measurably different on photographs 20 and 21 by the Metropolitan Police Department. The rear line of the butt is at an angle to the perpendicular to the bore. On the Archives specimen it is 6.5°; on the extra specimen it is 10°. The bottom straight line of the stock is at an angle to the bore. On the Archives specimen it is 18°; on the extra specimen it is 19°.

(227) There are many sources of error not accounted for in this analysis. The distortion of camera and enlarging lenses has been mentioned. In addition, film changes size and shape during processing and subsequent to processing as the temperature and humidity change. The same may be said of paper prints. Finally, there are natural limits to the precision of measurements involving decisions as to the exact endpoints to set on, interpolation, parallax, inaccuracy of the scale used, and alinement of the scale with the center line.

Ultimately, however, when the computed distances were scaled to the photographs, the deviations from the Archives rifle amounted in most cases to a small fraction of a millimeter. It would be reasonable to expect that the effect of the potential errors cited would be of that magnitude.

Identifying Marks

(228) Twenty-one photographs were taken of the rifle in the National Archives in Washington, D.C., on April 18, 1978. These photographs, figures 4a–u, are numbered from A–1 to A–21 in the upper right-hand corner. See table 6. Identifying marks are lettered on the photographs. Table 7 indicates the earlier photographs from the preceding section on which the same marks may be observed. There are 56 citations of 22 different identifying marks on the early photographs, and 13 on the photograph of the alleged assassination weapon that was recently made by the Metropolitan Police Department of Washington, D.C. The list of identifying marks includes the more prominent markings found on the photographs from the preceding section but is not exhaustive. In many cases, smaller or less prominent nearby marks are seen as well.

(229) Identifying mark L refers to the pattern of vertical lines apparently left in the horizontal groove by the woodworking operation used in manufacturing the stock. These may be regarded as several points of evidence. The mark "VE [trefoil] K" (identification mark U), the date "November 22, 1963," and "PMS" or "RMS" "November 1963", have been scratched into the butt, as shown on pictures A–6, A–10, A–11, A–16, and A–21, possibly by law enforcement officials. Only the trefoil of mark U appears on the Fort Worth Star Telegram

photograph No. 13 in table 1, but the initials in identification mark U are seen on photograph No. 15 taken by the Dallas Police Department later that day. The lighting revealing the trefoil should have revealed the initials immediately to either side of it in picture 13 if they were, in fact, there at the time that the picture was taken. None of the cited identifying marks were observed on photograph No. 21 of another specimen of the same kind of rifle.

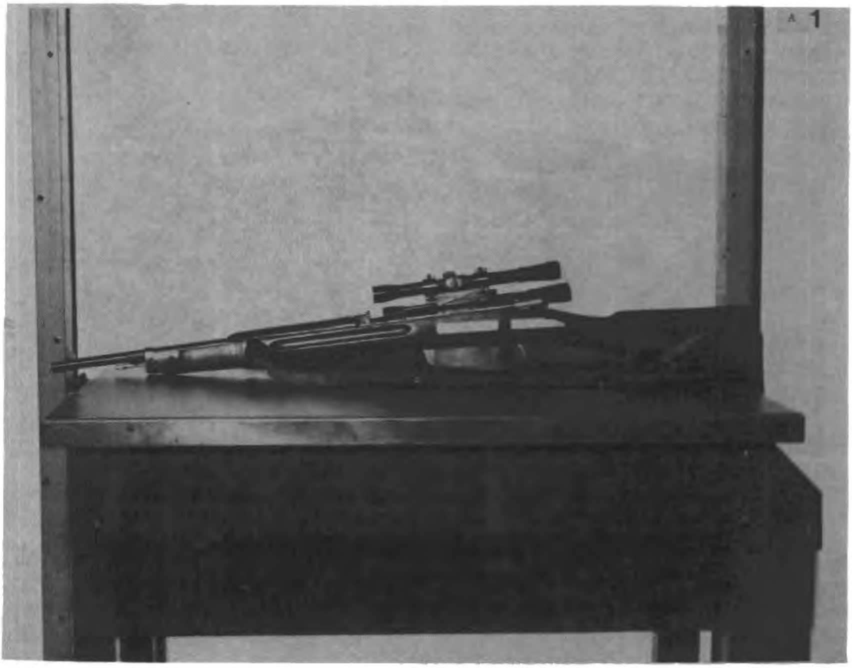


FIGURE III–4a.—McCamy's Archives rifle photograph.

FIGURE III–4b.—McCamy's Archives rifle photograph.

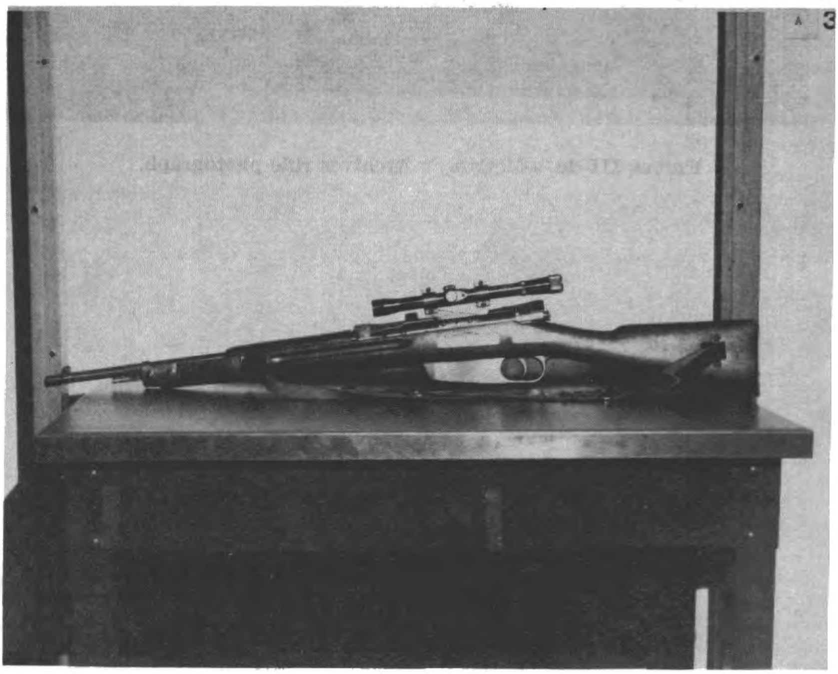


FIGURE III–4c.—McCamy's Archives rifle photograph.

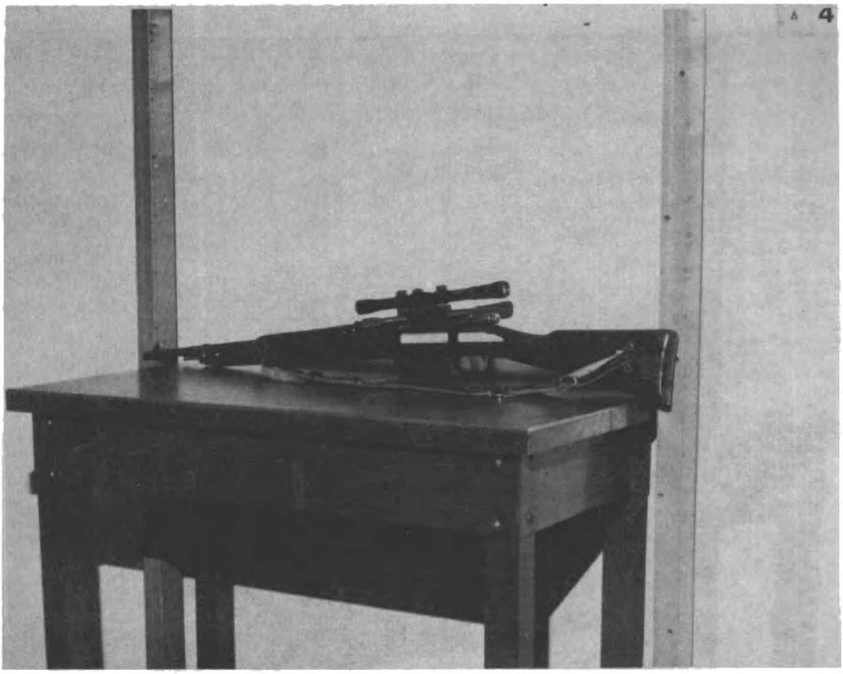


FIGURE III–4d.—McCamy's Archives rifle photograph.

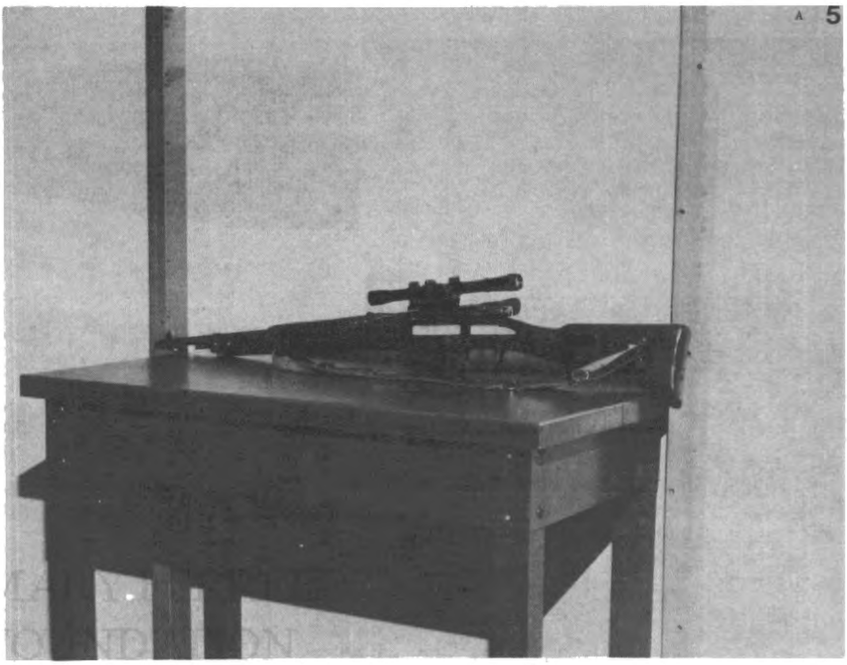


FIGURE III–4e.—McCamy's Archives rifle photograph.

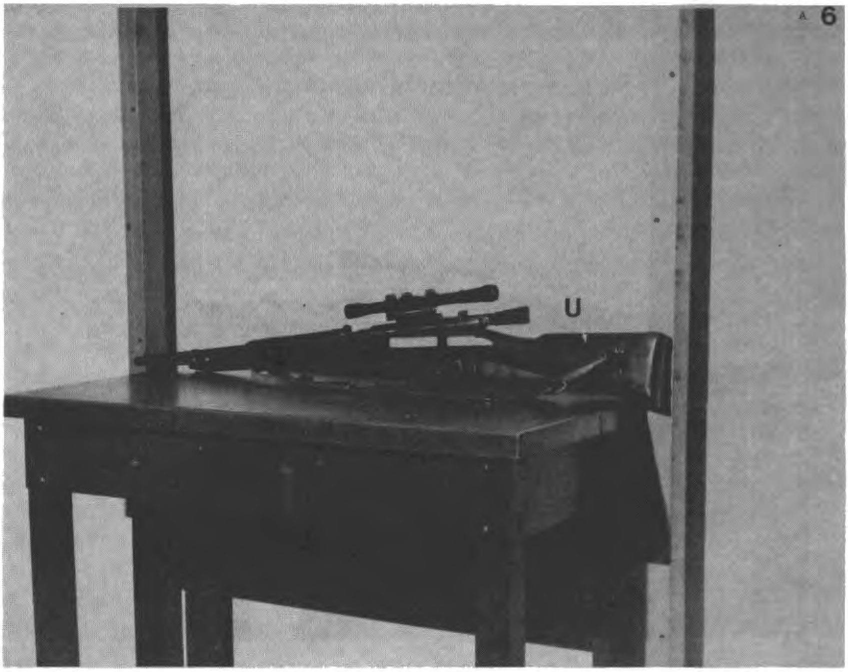


FIGURE III–4f.—McCamy's Archives rifle photograph.

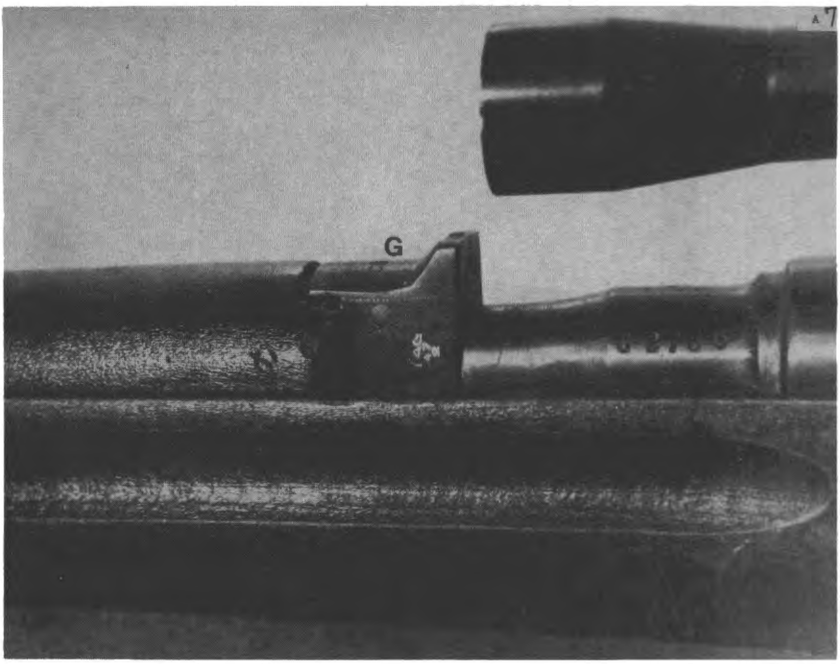


FIGURE III–4g.—McCamy's Archives rifle photograph.

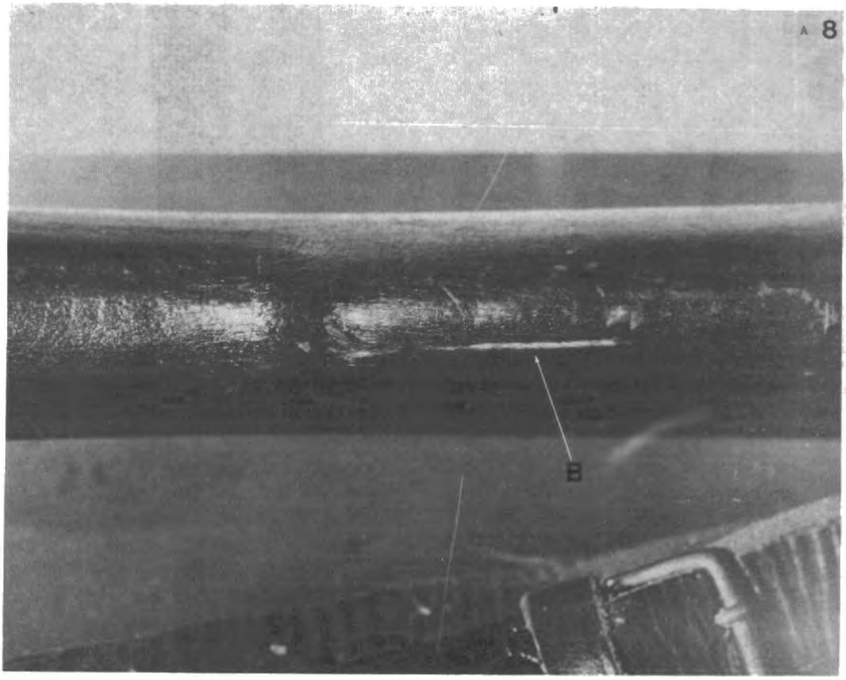


FIGURE III-4h.—McCamy's Archives rifle photograph.

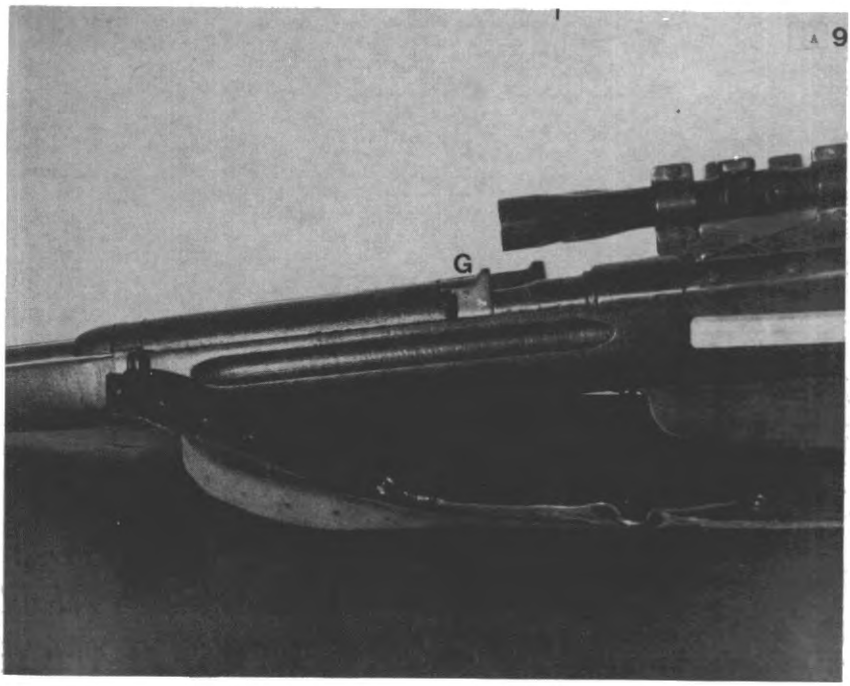


FIGURE III-4i.—McCamy's Archives rifle photograph.

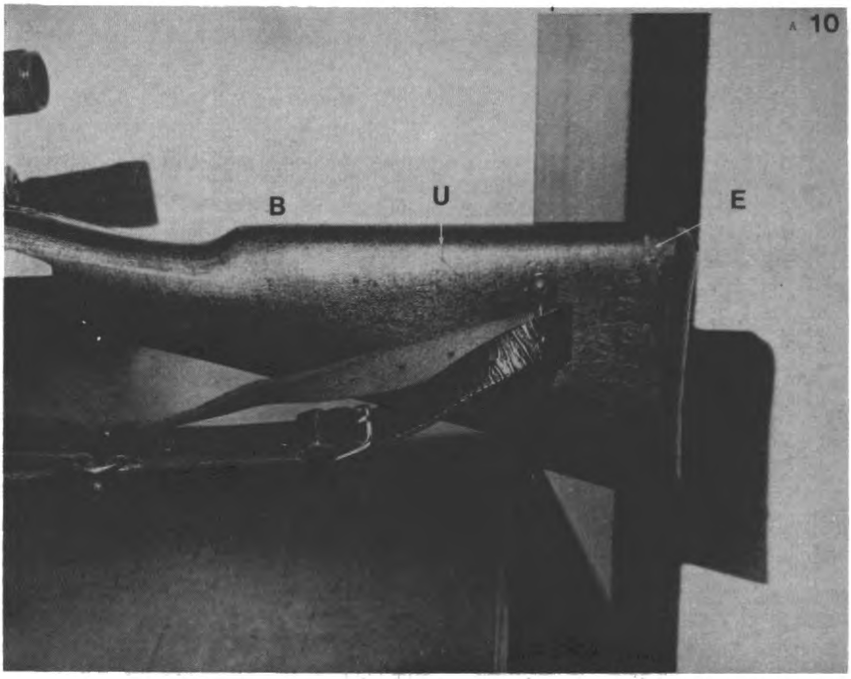


FIGURE III–4j.—McCamy's Archives rifle photograph.

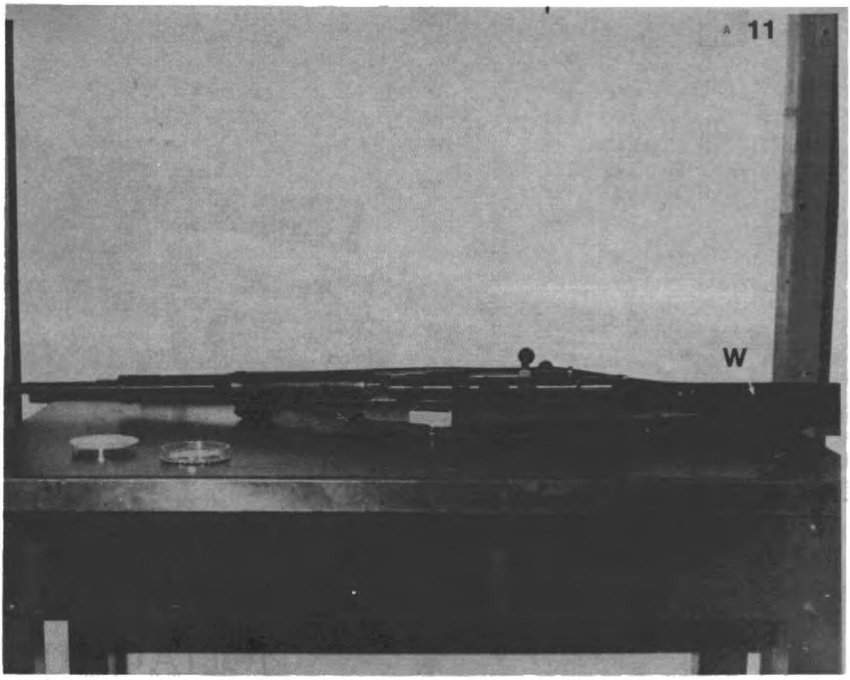


FIGURE III–4k.—McCamy's Archives rifle photograph.

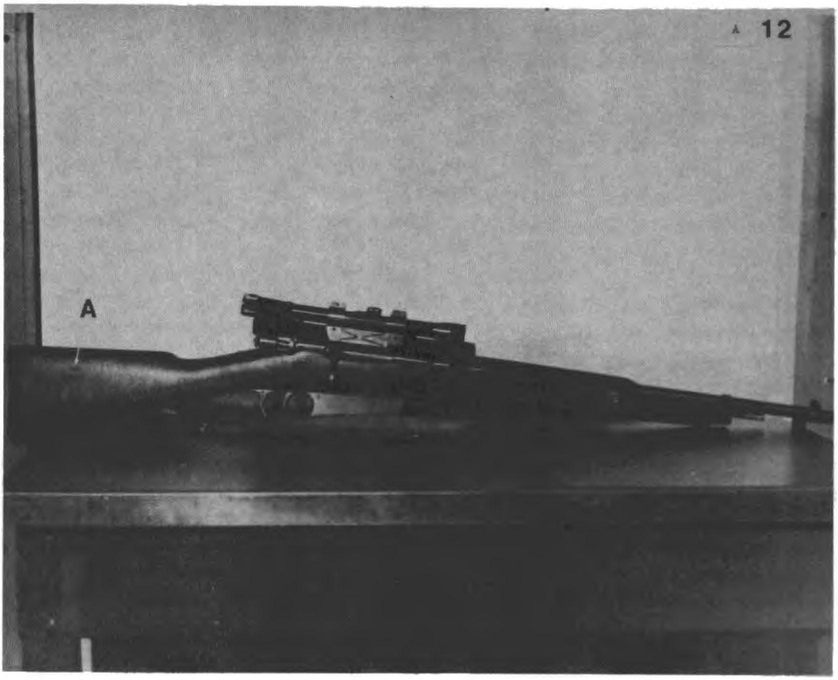


FIGURE III-4l.—McCamy's Archives rifle photograph.

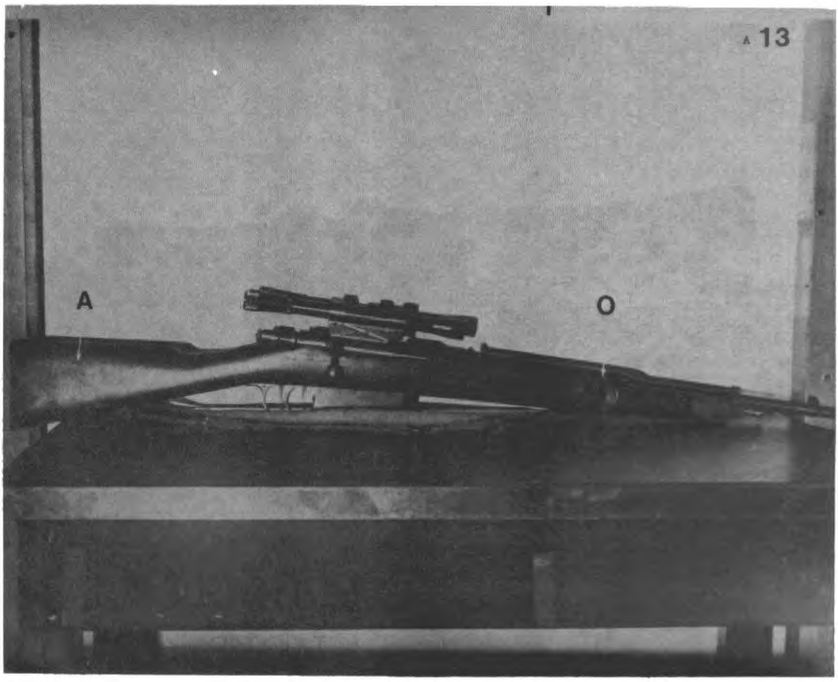


FIGURE III-4m.—McCamy's Archives rifle photograph.

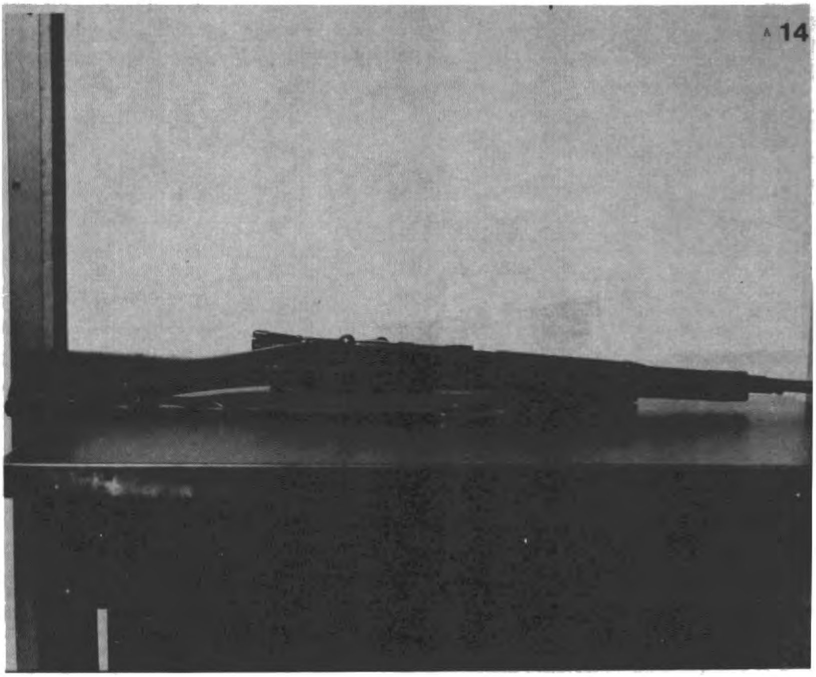


FIGURE III-4n.—McCamy's Archives rifle photograph.

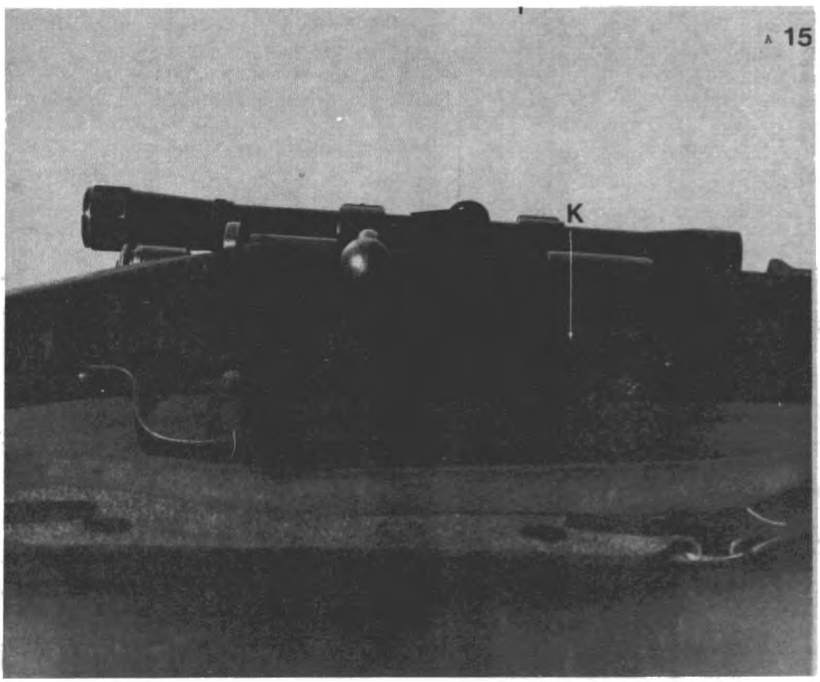


FIGURE III-4o.—McCamy's Archives rifle photograph.

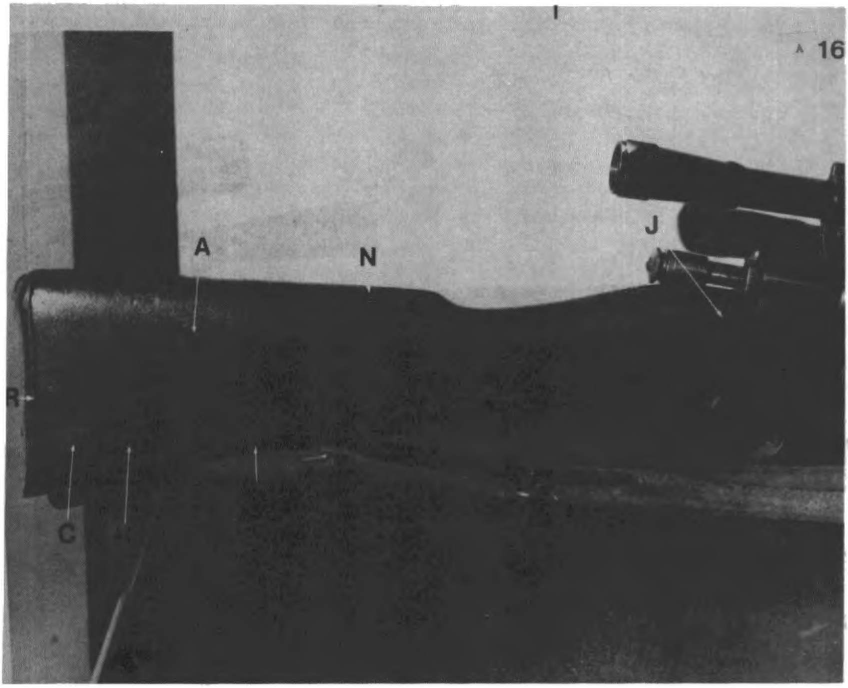


FIGURE III–4p.—McCamy's Archives rifle photograph.

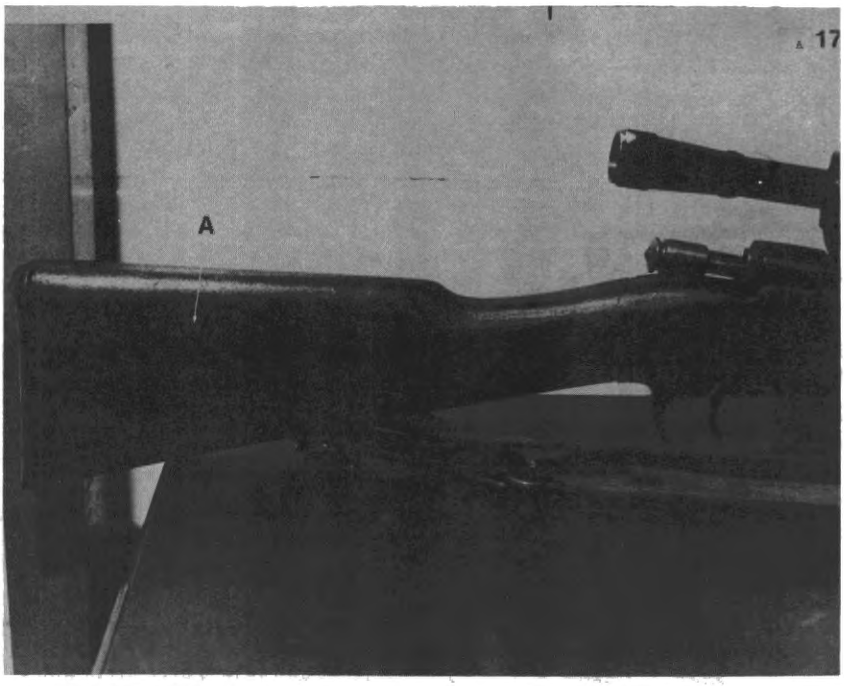


FIGURE III–4q.—McCamy's Archives rifle photograph.

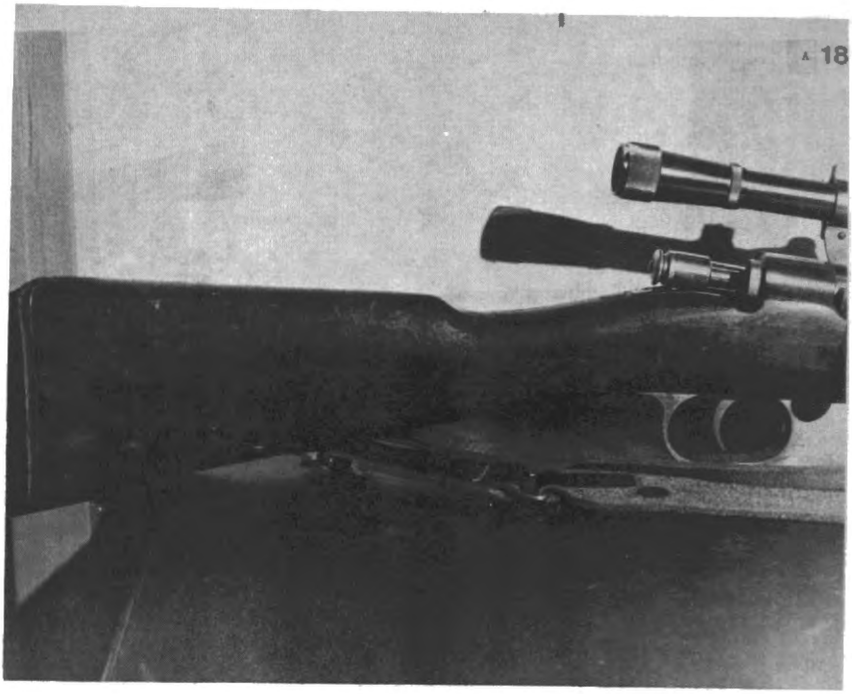


FIGURE III–4r.—McCamy's Archives rifle photograph.

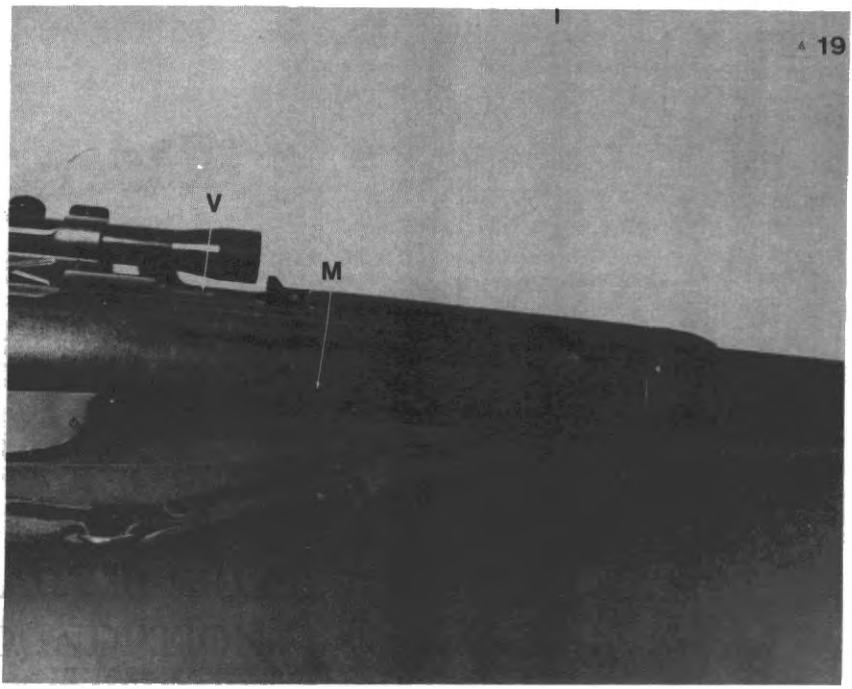


FIGURE III–4s.—McCamy's Archives rifle photograph.

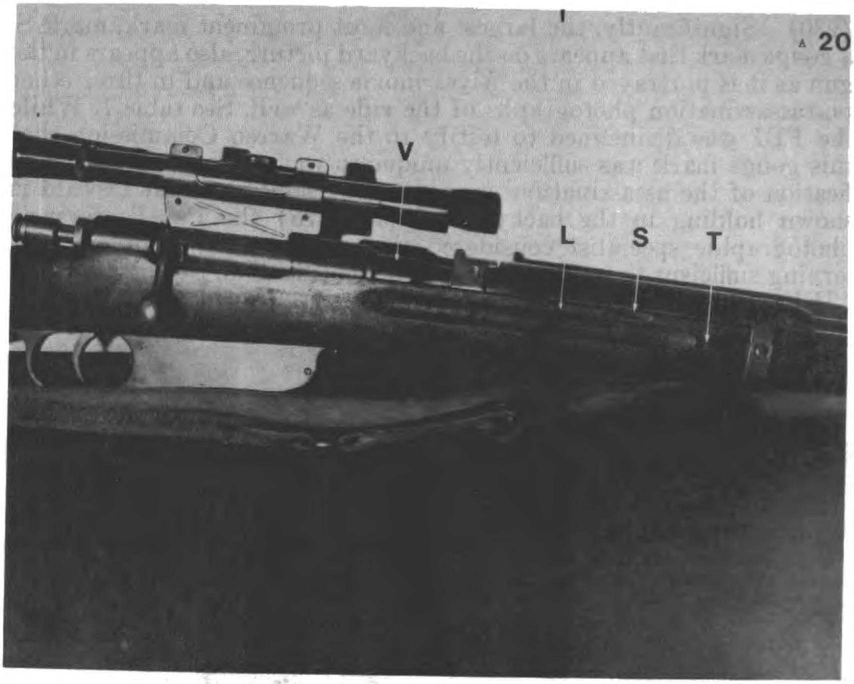


FIGURE III-4t.—McCamy's Archives rifle photograph.

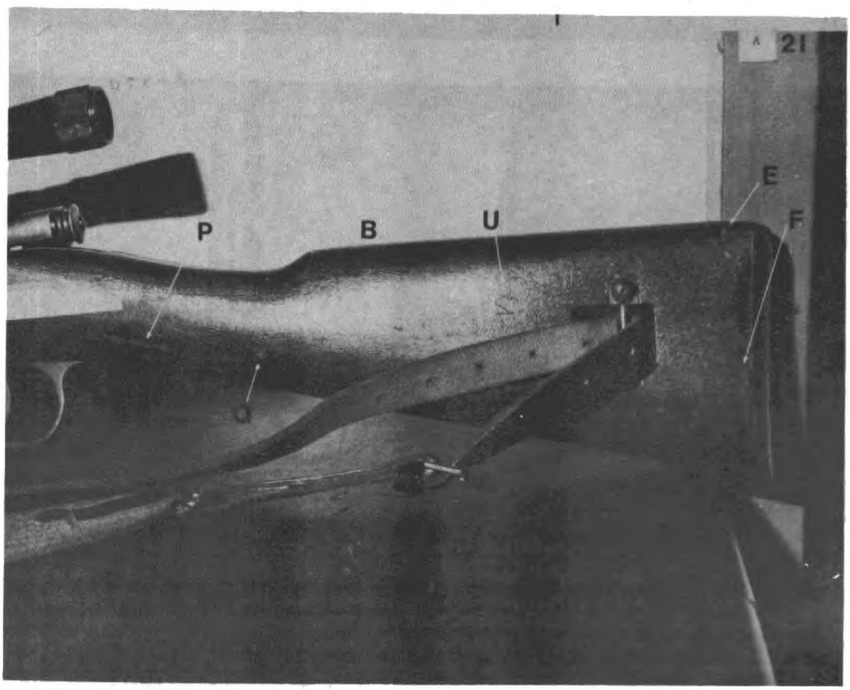


FIGURE III-4u.—McCamy's Archives rifle photograph.

(230) Significantly, the largest and most prominent mark, mark S, a gouge mark that appears on the backyard picture, also appears in the gun as it is portrayed in the Alyea movie sequence and in three other postassassination photographs of the rifle as well. See table 7. While the FBI was disinclined to testify to the Warren Commission that this gouge mark was sufficiently unique to warrant a positive identification of the assassination weapon as the same gun that Oswald is shown holding in the backyard picture, (*78*) the Panel's forensic photographic specialist considered this mark to be a random patterning sufficient to warrant a positive identification. See figure III–8 (JFK exhibit F–206 and addendum C).

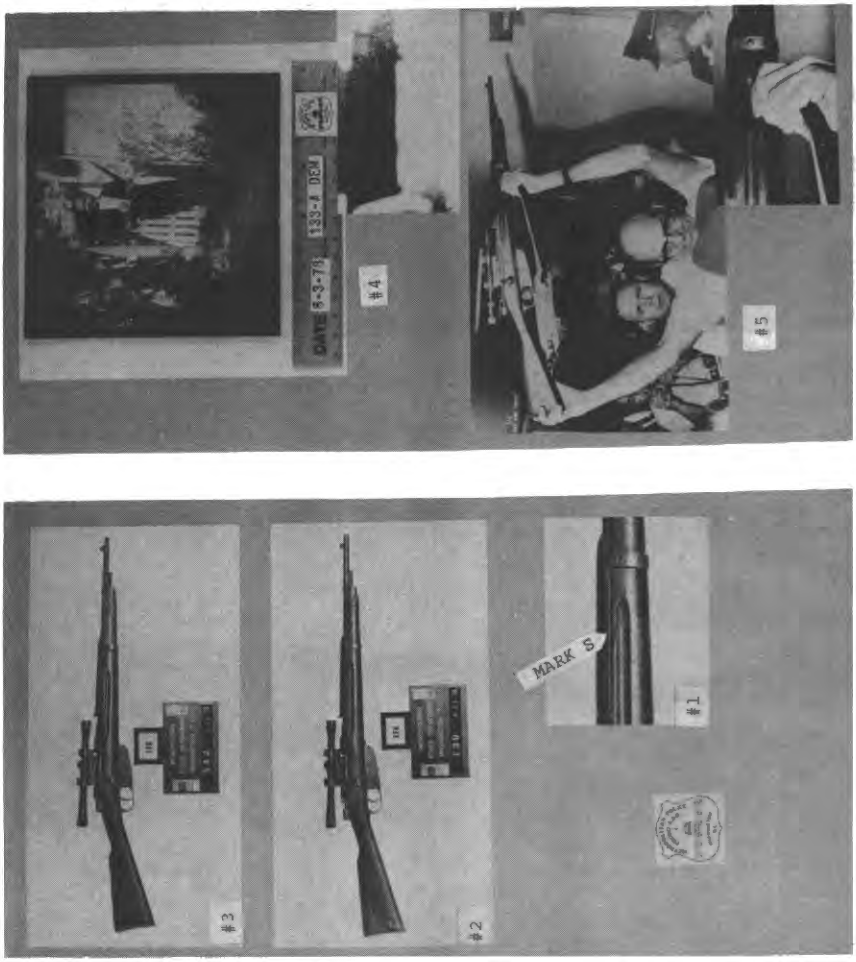


FIGURE III–8.—(JFK exhibit F–206) Identifying mark S (gouge on forestock) considered to be a "random pattern." (See addendum D.) Clockwise from left: Enlargement of Archives rifle shows mark S (No. 1); Archives rifle (No. 2) and another Mannlicher-Carcano (No. 3)—mark S only visible on No. 2; de Mohrenschildt print of CE 133–A (No. 4) and Fort Worth Star Telegram photograph of rifle shortly after discovery (No. 5); marks visible on enlargements of both photographs.

(231) Finally, the most common misconception regarding photographic evidence is the idea that all photographs of the same object must look alike. The appearance of the image depends on level and directions of illumination, point of view, kind of film or plate, exposure, focus, and a host of other factors. Pictures A–1, A–2, and A–3 in this series were made with the camera and rifle in the same position; only the lighting was changed. Note the difference in appearance, particularly in the wooden parts. Picture A–1 is directionally lighted from the upper left, picture A–3 from the upper right, and picture A–2 was diffusely lighted from overhead. The same kinds of differences are seen in A–5 and A–6, in A–7 and A–9, in A–6, A–7, and A–8 and in A–10 and A–21. Note that mark A appears light on a dark background on picture A–1, but dark on a light background in picture A–2, simply because the lighting is different. One must be careful not to conclude that marks were not on the rifle at the time a picture was made simply because the marks are not seen in the picture.

Conclusion

(232) 1. A comparison of the relative lengths of parts of the alleged assassination rifle that is in the National Archives with corresponding parts of what purports to be that rifle as shown in various photographs taken in 1963 indicates that the dimensions of the rifle(s) depicted are consistent.

(233) 2. A comparison of identifying marks that exist on the rifle as shown in photographs today with marks shown on the rifle in photographs taken in 1963 indicates both that the rifle in the Archives is the same weapon that Oswald is shown holding in the backyard picture, and the same weapon that was seized by Dallas Police and appears in various postassassination photographs.

TABLE 1.—PHOTOGRAPHS ANALYZED

[In chronological order of original image]

Exhibit No. and photo No.	Identification No.	Source	Description
III—3a:			
0[1]	133–A	Dallas Police (Oswald)	Backyard photograph.
1	HSCA 003403	Dallas Police	Rifle where found.
III—3b:			
1a[1]	HSCA 007536	WFAA–TV, T. Alyea	Movie in book depository.
2	HSCA 003295	Dallas Times Herald, Allen 5–11	Rifle carried in street.
3	HSCA 003295	Dallas Times Herald, Allen 5–12	Do.
III—3c:			
3a[1]	HSCA 003295	McCamy's print of above	Do.
4	HSCA 003295	Dallas Times Herald, Allen 5–13	Do.
5	HSCA 003295	Dallas Times Herald, Allen 5–15	Do.
III—3d:			
5a[1]		McCamy's print of above	Do.
6	HSCA 003294	United Press International	(Enlargement of No. 5).
7	HSCA 003295	Dallas Times Herald, Allen 5–16	Rifle carried in street.
8	HSCA 003294	United Press International	(Enlargement of No. 7).
9	HSCA 003295	Dallas Times Herald, Allen 5–17	Rifle carried in street.
10	HSCA 003295	Dallas Times Herald, Allen 5–18	Do.
III—3e: 11[1]	HSCA 003356	Fort Worth Star Telegram	Rifle in police station.
III—3f: 12[1]	HSCA 003294	United Press International No. 1402594	Do.
III—3g: 13[1]	HSCA 003356	Fort Worth Star Telegram	Do.
III—3h: 14[1]	HSCA 003403	Dallas Police Department	Laboratory photograph.
III—3i: 15[1]	HSCA 003403	do	Do.
III—3j:			
16	HSCA 003403	do	Do.
17		do	(Negative) laboratory photograph.
III—3k:			
18[1]		Federal Bureau of Investigation	Laboratory photograph.
19		McCamy	Rifle in National Archives.
III—3l:			
20[1]	MPD 139 4–15–78	Metropolitan Police Dept., Wash., DC	Laboratory photograph.
21	MPD 542 4–15–78	do	Laboratory photo of a different specimen of this kind.

[1] See table 7, photographs depicting ID marks.

TABLE 2.—*Selected points on the rifle and rifle images*

(Measurements were made from the rear sight to each selected point)

1. Muzzle.
2. Front of band supporting front sight.
3. Rear of band supporting front sight.
4. Front end of bayonet mount.
5. Front end of bayonet mount ring.
6. Front end of ring over the stock clamp.
7. Front end of stock band.
8. Rear flat of rear sight.
9. Front of trigger guard.
10. Front of trigger.
11. Rear of bolt (bolt closed).
12. Comb.
13. Butt.

TABLE 3.—LENGTHS MEASURED ON ENLARGEMENTS (mm)

Point	Photograph No. 0[1]	3a	5a	11	12	14	15	16	17[2]	18	19	20	21
1	−37.7	−115.3	103.4	54.2	84.0	−64.3	53.2	50.4	−28.1	94.1	−101.8	−107.6	105.8
2	−35.9	−109.2	98.8	51.8	80.0	−60.7	51.1	48.1	−26.6	89.8	−96.7	−102.2	100.8
3	−35.0	−106.5	96.1	50.2	78.0	−58.7	49.2	47.0	−25.7	86.7	−94.3	−99.6	98.0
4	−30.0		84.5	44.6	67.8	−50.4	43.7	40.8	−22.4	76.3	−81.6	−86.2	84.6
5	−28.2	−86.5	80.2	42.7	64.8	−47.3	41.4		−21.2	72.8	−77.5	−82.0	80.6
6	−26.6	−80.0	74.7	39.5	60.5	−43.8	38.4	37.0	−19.7	67.3	−72.0	−76.3	75.0
7	−15.0	−44.7	43.0	23.8	34.6	−23.8	22.2	21.2	−11.0	39.2	−40.9	−43.3	42.5
8	0	0	0	0	0	0	0	0	0	0	0	0	0
9			−16.0	−9.0	−12.9	8.0	−8.6	−8.3	3.7	−14.3	14.6	15.3	−15.5
10				−30.0	−39.7	23.7	−26.5	−26.0	12.0	−46.6	46.0	48.6	−48.4
11	20.2		−63.0	−36.3	−49.5	29.8	−33.8	−33.0	15.0		56.4	60.0	−56.4
12		76.5	−87.0	−53.0	−68.2	39.7	−46.8	−45.8	20.0	−80.1	77.6	82.3	−81.1
13	42.2	115.7	−138.0	−86.3	−107.0	58.6	−75.4	−73.0	30.6	−126.8	119.0	127.3	−126.4

[1] For an analysis of photograph 1a, taken by T. Alyea, which shows the rifle at the time that it was discovered by Dallas police officials, see addendum C.

[2] Measured on the negative.

TABLE 4.—DERIVED PHOTOGRAMMETRIC CONSTANTS

Photograph No.	Enlarger magnification M	Axial image distance v(mm)	Object distance u(mm)	Tilt angle t (degrees)	Photograph No.	Enlarger magnification M	Axial image distance v(mm)	Object distance u(mm)	Tilt angle t (degrees)
0[1]	3.343	78.8	3,419	7.515	16	2.1	134.9	2,177	24.97
3a	14.18	50.9	2,800	27.63	17	1	134.5	2,277	11.17
5a	16.0	50.8	3,237	21.5	18	1	396.0	1,807	12.90
11	6.94	35.76	1,660	28.06	19	9.222	51.65	2,194	1.963
12	7.0	35.94	1,346	5.339	20	3	107.69	1,401	.2874
14	2.1	135.6	2,004	31.47	21	3	107.59	1,417	.4880
15	2.1	135.0	2,136	21.73					

[1] For the analysis of photograph 1a, taken by T. Alyea, which shows the rifle at the time that it was discovered by Dallas police officials, see addendum C.

TABLE 5.—COMPUTED LENGTHS OF PHOTOGRAPHED RIFLE COMPONENTS COMPARED TO MEASURED COMPONENTS ON ARCHIVES RIFLE

[Lengths in millimeters]

Archives rifle	Photograph No.												
	0[1]	3a	5a	11	12	14	15	16	17	18	19	20	21[2]
465.8	465.8	465.9	465.8	465.8	465.9	465.9	465.7	465.8	465.7	465.9	465.8	465.8	465.8
442.3	445.1	443.0	443.8	442.4	441.9	443.0	445.9	442.7	441.8	443.4	442.8	442.4	443.7
431.0	432.7	432.9	431.7	427.1	429.9	430.7	428.1	432.2	427.4	427.3	431.9	431.2	431.4
373.0	370.4		377.0	374.8	373.9	375.2	377.4	370.1	374.2	373.7	373.9	372.8	372.2
355.9	353.7	356.4	357.0	356.8	356.9	353.9	356.3		354.8	355.8	355.0	354.6	354.6
329.7	332.8	331.0	331.8	327.7	332.5	330.9	329.5	333.6	330.4	327.8	330.2	330.0	329.9
188.4	189.9	189.4	188.2	190.5	188.2	186.3	186.4	186.3	186.8	187.8	188.2	187.2	186.8
0	0	0	0	0	0	0	0	0	0	0	0	0	0
66.4			68.0	67.2	68.9	67.0	69.0	70.2	64.2	66.4	67.2	66.4	68.1
213.3				213.8	210.2	206.3	206.9	211.7	210.8	212.4	212.8	210.9	212.2
261.8	261.7		261.8	262.0	261.1	262.9	261.8	265.1	264.7		261.2	260.4	[3] 247.2
359.0		354.3	357.5	361.3	357.3	358.0	356.4	360.9	355.6	358.4	359.9	356.8	[4] 355.2
553.0	552.9	553.1	553.4	552.8	553.1	553.1	552.9	553.1	552.9	553.0	553.0	553.0	553.0

[1] For the analysis of photograph Ia, taken by T. Alyea, which shows the rifle at the time that it was discovered by Dallas police officials, see addendum C.
[2] A different specimen of the same kind of rifle.
[3] Bolt apparently in firing position.
[4] Small discrepancy between the butts of the two specimens.

TABLE 6.—*Photographs of rifle in the Archives exhibiting identifying marks*

Mark:	*(McCamy) National Archives photograph No. A—*
A	12, 13, 16, 17.
B	8, 10, 21.
C	16.
D	16.
E	10, 21.
F	21.
G	7, 9.
H	16.
J	16.
K	15.
L	20.
M	19.
N	16.
O	13.
P	21.
Q	21.
R	16.
S	20.
T	20.
U	6, 10, 21.
V	19, 20.
W	11.

FIGURE III–3a.—Table 7. Table 1 (photograph No. 0).

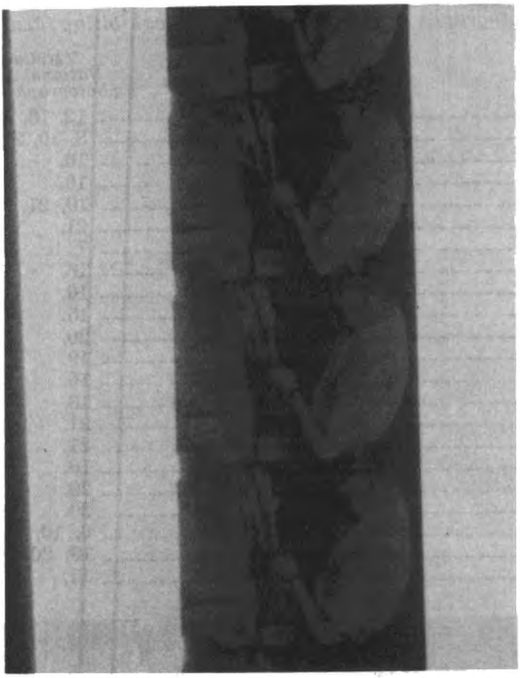


FIGURE III—3b.—Table 7. Table 1 (photograph No. 1a). (See attachment c).

FIGURE III–3c.—Table 7. Table 1 (photograph No. 3a).

FIGURE III–3d.—Table 7. Table 1 (photograph No. 5a).

FIGURE III-3e.—Table 7. Table 1 (photograph No. 11).

FIGURE III-3f.—Table 7. Table 1 (photograph No. 12).

FIGURE III-3g.—Table 7. Table 1 (photograph No. 13).

FIGURE III-3h.—Table 7. Table 1 (photograph No. 14).

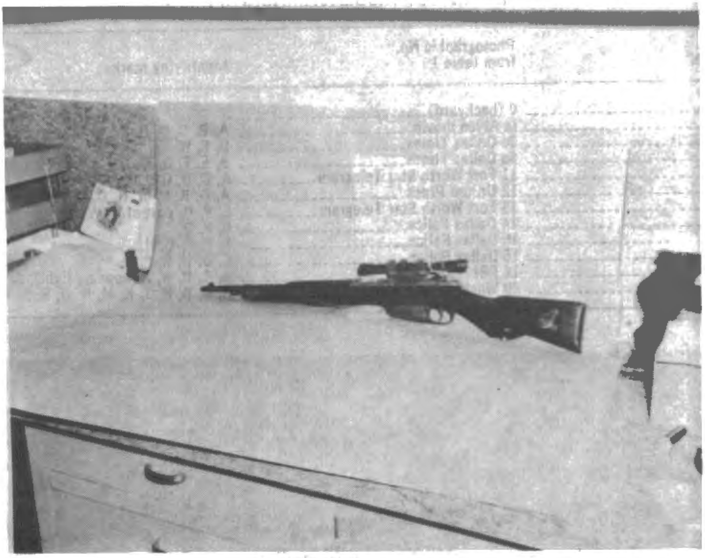


FIGURE III–3i.—Table 7. Table 1 (photograph No. 15).

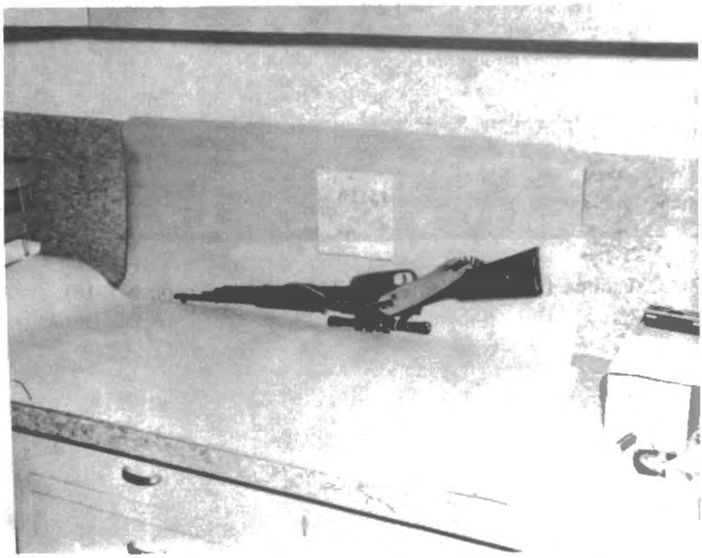


FIGURE III–3j.—Table 7. Table 1 (photograph No. 16).

TABLE 7.—PHOTOGRAPHS DEPICTING IDENTIFYING MARKS

Exhibit No.	Photographic No. from table 1	Identifying marks
III-3a	0 (backyard)	S.
III-3b	la Alyea movie	A, B, C, D, H, S.
III-3c	3a Dallas Times	B, E, W.
III-3d	5a Dallas Times	B, E, F, G, W.
III-3e	11 Fort Worth Star Telegram	A, C, D, G, J, K.
III-3f	12 United Press	A, D, K, L, M, N, O, S, T.
III-3g	13 Fort Worth Star Telegram	E, P, Q, part of U, W.
III-3h	14 Dallas Police	E, P, Q.
III-3i	15 Dallas Police	E, F, P, Q, U.
III-3j	16 Dallas Police	C, D, H, R, S, T.
III-3k	18 FBI	A, C, D, H, R (appears light), S, V.
III-3l	20 Washington Police	A, C, D, H, J, K, M, N, O, R, S, T, V.

FIGURE III-3k.—Table 7. Table 1 (photograph No. 18).

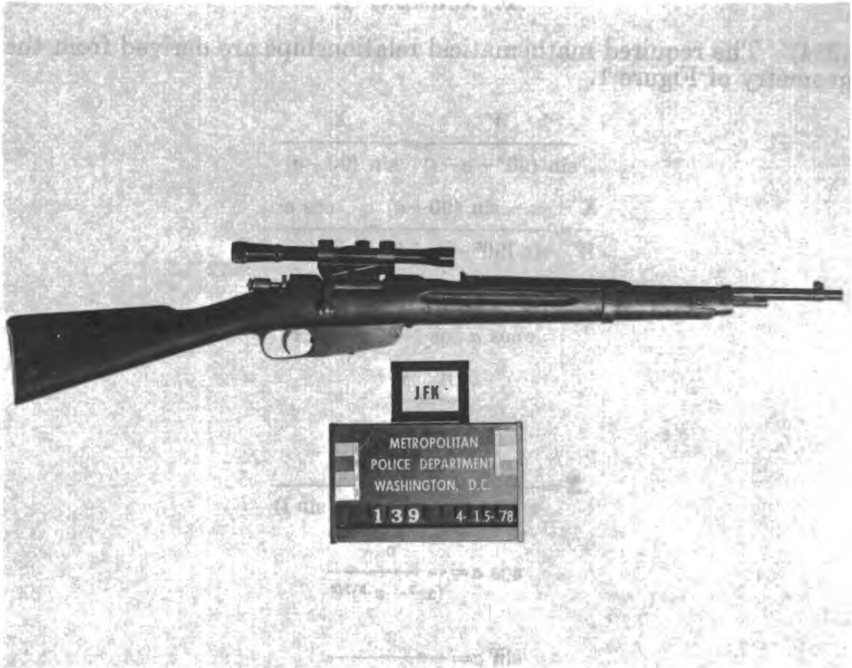


FIGURE III–31.—Table 7. Table 1 (photograph No. 20).

TABLE 8.—ERROR ANALYSIS

	Archives rifle (mm)	Mean value (mm)	Average deviation from mean (mm)	Difference from archives rifle
Part No.:				
1	465.8			
2	442.3	443.2	0.8	0.9
3	431.0	430.3	1.9	—.7
4	373.0	373.9	1.6	.9
5	355.9	355.6	1.1	—.3
6	329.7	330.7	1.6	1.0
7	188.4	187.9	1.1	—.5
8	0			
9	66.4	67.45	1.3	1.05
10	213.3	210.6	1.9	—2.7
11	261.8	262.3	1.2	.5
12	359.0	357.9	1.7	—1.1
13	553.0			

Note: Average absolute difference: 1.0 mm.

ATTACHMENT A

(234) The required mathematical relationships are derived from the geometry of Figure 1.

$$\frac{W}{\sin(90^\circ - a - t)} = \frac{X}{\sin(90 + a)}$$

$$\frac{X}{W} = \frac{\sin(90 + a)}{\sin[90^\circ - (a + t)]} = \frac{\cos a}{\cos(a + t)}$$

$$X = \frac{W \cos a}{\cos a \cos t - \sin a \sin t}$$

$$\frac{W}{u} = \frac{x}{v}$$

$$X = \frac{ux \cos a}{v(\cos a \cos t - \sin a \sin t)}$$

$$\cos a = \frac{v}{(x^2 + v^2)^{1/2}}$$

$$\sin a = \frac{x}{(x^2 + v^2)^{1/2}}$$

$$X = \frac{ux}{(x^2 + v^2)^{1/2}\left(\frac{v \cos t}{(x^2 + v^2)^{1/2}} - \frac{x \sin t}{(x^2 + v^2)^{1/2}}\right)}$$

$$X = \frac{ux}{v \cos t - x \sin t}$$ (First equation of paragraph 207)

Given:

the axial image distance v
rifle length, rear sight to the end tilted away X_1
rifle length, rear sight to the end tilted toward X_2
image length, rear sight to the end tilted away x_1
image length, rear sight to the end tilted toward x_2

$$X_1 = \frac{ux_1}{v \cos t - x_1 \sin t} \qquad X_2 = \frac{ux_2}{v \cos t - x_2 \sin t}$$

eliminate u: $\frac{X_1}{x_1}(v \cos t - x_1 \sin t) = \frac{X_2}{x_2}(v \cos t - x_2 \sin t)$

$$\frac{X_1}{x_1} v \cos t - X_1 \sin t = \frac{X_2}{x_2} v \cos t - X_2 \sin t$$

$$(X_2-X_1)\sin t=\left(\frac{X_2}{x_2}-\frac{X_1}{x_1}\right)v\cos t$$

$$\tan t=\left(\frac{X_2}{x_2}-\frac{X_1}{x_1}\right)\frac{v}{X_2-X_1}$$ (Equation in paragraph 208)

$$X_1=\frac{ux_1}{v\cos t-x_1\sin t}$$

$$u=\frac{X_1}{x_1}(v\cos t-x_1\sin t)$$ (Equation in paragraph 211)

The equation in paragraph 205 and the second equation in paragraph 207 are well known in elementary optics.

ATTACHMENT B

No. 009215.

(235) U.S. DEPARTMENT OF THE INTERIOR,
GEOLOGICAL SURVEY,
Reston, Va., May 5, 1978.

REPORT OF CALIBRATION
OF 2¼ x 2¼ CAMERA

Camera type 620 Imperial Reflex.
Lens type DUO.
Nominal focal length 77 mm.
Camera: Commission.
Identification: Exhibit No. 750.
Maximum aperture f/12.5*.
Test aperture f/12.5.

SUBMITTED BY SELECT COMMITTEE ON ASSASSINATIONS, U.S. HOUSE OF REPRESENTATIVES

Reference: Letter dated March 2, 1978 from Mr. Michael Goldsmith.

These measurements were made on Kodak Verichrome Pan film type 620, developed in D–19 at 68°F for 3 minutes with continuous agitation. This film was exposed on a multicollimator camera calibrator using a white light source rated at approximately 3500K.

I. *Equivalent Focal Length:* 77.55 mm.

This measurement is considered accurate within 0.02 mm.

II.—RADIAL DISTORTION

Field angle (degrees)	$\bar{D}_c$	D_c for azimuth angle 0	90	180	270
7.5	0	61	−25	−44	7
15	388	611	331	260	350
22.5	1,706			1,646	1,767

*This is a nominal value as the shutter is not equipped with either a T (Time) or B (Bulb) setting for holding the aperture in the open position.

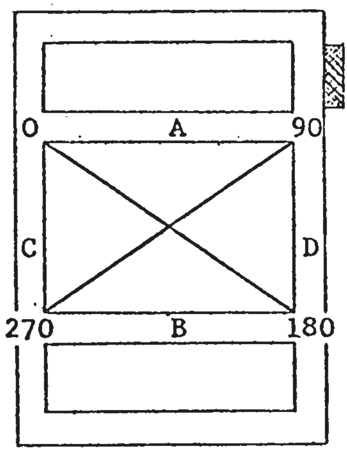
The radial distortion is measured for each of 4 radii of the focal plane separated by 90° in azimuth. $\overline{D}_c$ is the average distortion for a given field angle. Values of distortion D_c are based on the equivalent focal length referred to the field angle co-tangent for 7.5°. The radial distortion is given in micrometers and indicates the radial displacement of the image from its distortion free position. A positive value indicates a displacement away from the center of the field. These measurements are considered accurate within 10 μm. It is clear from these variations in the values reported among the four radii from the average that a substantial amount of asymmetric distortion is present in this lens.

III.—RESOLVING POWER IN CYCLES/mm

Field angle	0°	7.5°	15°	22.5°
Radial lines	14	16	20	----------
Tangential lines	20	20	10	----------

The resolving power is obtained by photographing a series of test bars and examining the resulting image with appropriate magnification to find the spatial frequency of the finest pattern in which the bars can be counted with reasonable confidence. The series of patterns has spatial frequencies from 10 to 223 cycles/mm in a geometric series having a ratio of the 4th root of 2. Radial lines are parallel to a radius from the center of the field, and tangential lines are perpendicular to a radius.

IV. Indicated Principal Point



Positions of all points are referenced to the indicated principal point as origin. The diagram indicates the orientation of the referenced points when the camera is viewed from the back. The direction of film travel is to the top.

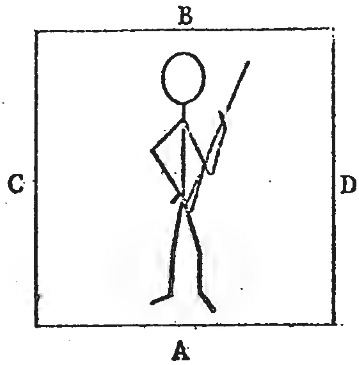
Indicated principal point to midsides of focal frame:

A	Unable to measure.
B	28.79 mm.
C	27.96 mm.
D	29.34 mm.

These measurements were made from a shadow image formed in the focal plane. The method of measuring these distances is considered accurate within 0.01 mm.

The camera was alined for calibration by autocollimating on the mounting surface where the front of the test camera-lens was placed for the film exposures. It is evident, however, that this is an indirect procedure, but the only method possible for a camera of this type. This alinement process made the front of the lens ring normal to the axis of the collimator beam emergent from the 0° collimator.

V. Camera Negative



The diagram indicates the orientation, with emulsion-up of a negative submitted for focal frame measurements.

Distances between midsides:

A–B	57.10 mm.
C–D	57.14 mm.

The method of measuring these distances is considered accurate within 0.01 mm.

William P. Tayman,
Branch of Research and Design,
Topographic Division.

Attachment C

ALYEA FILM STUDY

(By C. S. McCamy)

(236) After the President was shot, the Dallas police searched the Texas School Book Depository and found a rifle. While the search was in progress, a motion picture was being made by T. Alyea of Dallas television station WFAA. I studied a 16-mm copy of that motion picture film. I did not find a satisfactory single frame displaying the entire length of the rifle. The frame selected for analysis was about 55 feet into the film. It depicts a man displaying the rifle in the book depository. The frame may be identified by a prominent lint mark on the film that is located on the image of the man's shoulder. Measure-

ments to the nearest 0.0001 inch were made on the film by means of a Nikon measuring microscope. The computed constants were: tilt angle t = 23.1° with the muzzle tilted away from the camera, object distance u = 2511 mm, and image distance v = 25.66 mm. The measured and computed distances were as follows:

Part of rifle	Image (mm)	Rifle computed (mm)	Rifle in archives (mm)
Muzzle	2.50	277.5	277.4
Front of front sight	2.30	254.4	253.9
Rear of front sight	2.19	241.8	242.6
Bayonet mount	1.71	187.2	184.6
Mount ring			167.5
Stock clamp	1.31	142.5	141.3
Front of stock band	0	0	0
Rear of rear sight	−1.88	−193.9	−188.4
Front of trigger guard	−2.58	−263.2	−254.8
Front of trigger	−4.03	−401.8	−401.7

The conformity is well within the errors that might reasonably be expected when measuring such a small film. The very large deviation with respect to the front of the trigger guard should not be regarded as very significant because that piece of the rifle curves around to meet the line of the forestock in such a way that it is difficult to see or set a hairline on where it ends. The bolt, comb, and butt were not visible in this frame.

Attachment D

Random Pattern on Oswald Rifle

(Sgt. Cecil Kirk)

(237) As a piece of equipment is utilized, either properly or abused, one can expect that the utilization or abuse will leave individual artifacts or damage on that equipment that, when evaluated together, will be found to be unique to that piece of equipment. For example, an automobile that is 2 or 3 years old provides a classic example of random patterning. The nicks and dents on the doors and sides of the vehicle are mostly caused by the doors of other cars being pushed against it in parking lots. Because the car is parked in several locations adjacent to many cars of differing sizes, a pattern of abuse will develop on the vehicle. As that vehicle is driven, it will occasionally be struck by stones and other roadway debris that add additional nicks and dents to the surface of the vehicle. Minor damage caused by insignificant accidents will add other identifiers to the random pattern which in turn will make it even more unique. These are the elements that make up the pattern of artifacts caused by utilization of the vehicle.

(238) A military rifle will also establish a random pattern on its surface. After the weapon is disposed of by the military and is sold, stored, and resold as a civilian sporting weapon it will receive other elements of its individual pattern of damage. The Mannlicher-Carcano rifle in this case displays its own pattern of identifiers—its pattern of damage. Of the numerous artifacts on this particular weapon—one mark or pattern of abuse is very distinctive. It is a rather large gouge in the forestock of the weapon. It has a measurable shape, and, because

of its depth, photographs of the rifle reflect the gouge in a manner not unlike a crater on the moon, a tire impression on a muddy road, or a tool mark in soft metal.

(239) In the Lee Harvey Oswald backyard photographs identified as 133A Stovall, 133A de Mohrenschildt, and CE–134, that same gouge is quite visible and can be measured and compared with the gouge on the questioned rifle. They are identical in every respect.

(240) Based upon this system of identification, the rifle in these photographs can be positively identified as the same rifle that is presently in the custody of the National Archives. Finally, it should be noted that although an FBI expert declined to make a positive identification of the rifle in question based upon this gouge mark, this expert did not have access to all of the same quality photographic prints that were available to the Panel. For example, the 133A de Mohrenschildt and 133A Stovall prints, both of which are of high quality, were obtained and reviewed by the committee in 1977 and 1978 respectively. This was the first time that these materials were analyzed. In addition, positive identification of the rifle was based upon an examination of CE–134, a very good enlargement (from the original negative) of CE–133A.* The FBI's expert in 1964, however, apparently did not consider this photograph in reaching his conclusion.

B. Alleged Alibi Evidence—The Billy Lovelady Issue

[See pars. 759–70 *infra.*]

*Ibid.

IV. Conspiracy Questions

*A. Alleged Gunmen in Dealey Plaza**

1. INTRODUCTION

(241) A number of commentators and critics of the Warren Commission have asserted that photographic evidence exists which demonstrates that more than one gunman was present in Dealey Plaza.(*79*) The evidence includes an assortment of still- and motion-picture photography taken by the amateur and professional photographers present in the Plaza that day. If these films and pictures were ideal in quality, the questions they have raised might have been answered long ago. Nevertheless, there are limitations inherent in any photographic image,** and many of the issues concerning the number of gunmen in Dealey Plaza have arisen from interpretation of details that approach these inherent limitations. In some, the quality is too poor to allow an unambiguous interpretation of the images, resulting in differences of opinion.

(242) Because of the advances that have been made in the photographic sciences associated with image enhancement, (*80*) an effort was made to resolve the issues raised in photographs of the assassination by applying modern technology. It was understood, however, that because of inherent limitations to this technology not all image enhancement attempts would necessarily be successful and that, even when successful, the clarification obtained might not be sufficient to answer the questions that have been raised.(*81*)

2. ISSUE

(243) Is there any photographic evidence of a gunman or gunmen in Dealey Plaza at the time of the President's assassination?

3. MATERIALS AND PROCEDURES

(244) The available photographic materials were reviewed by the Panel and contractors. Those considered most relevant to the question of gunmen in Dealey Plaza (e.g., materials alleged to show a gunman, weapon, flash of light, puff of smoke) were selected for image

*This section was prepared under the direction of Bob R. Hunt, with the assistance of Harry Andrews, Robert Chiralo, Donald Janney, and Charles Leontis. For related public hearing testimony of Hunt, September 25, 1978. See HSCA–JFK Hearings, vol. IV, pp. 387, 420.

**The limitations inherent to photography can be classified as optical and photochemical, the former referring to the optical components which form an image, the latter to the processes which capture and permanently record the image. *See* J. C. Dainty and R. Shaw, *supra* note 2.

enhancement, provided that they were judged to have sufficient potential for meaningful improvement.[1]

(245) Based upon this review, the following photographic materials were selected for image enhancement.[2]

Dillard—35 millimeter black and white transparencies.
Powell—35 millimeter color transparency.
Hughes—8 millimeter color-motion-picture film.
Willis—35 millimeter color transparency.
Moorman—Polaroid print.
Zapruder—8 millimeter color-motion-picture film.
Nix—8 millimeter color-motion-picture film.

(246) Three different categories of image enhancement technology were available to the Panel: Photo-optical/photo-chemical, digital image processing, and autoradiography.[3] The selection of a particular technology depended upon the nature of the photograph and the type of clarification considered necessary.

4. CONCLUSIONS

(247) *a.* Evidence of changes in the open sixth-floor window of the Texas School Book Depository is visible. The changes are of two types:

(248) (*1*) There is an apparent rearranging of boxes within 2 minutes after the last shot was fired at President Kennedy;

(249) (*2*) There is an appearance or impression of motion in the open sixth-floor window a few seconds prior to the assassination. While the pattern of motion is not necessarily inconsistent with movement by a human being, it was nevertheless considered probably to be photographic artifacts.

(250) *b.* There is no visible evidence of anyone at the closed windows adjacent to the open sixth-floor window of the Texas School Book Depository. Motion in these windows was also attributed to photographic artifact.

(251) *c.* There is no definitive visible evidence of any gunmen in the streets, sidewalks, or areas adjacent to Dealey Plaza. Nor was any evidence discerned of a flash of light or puff of smoke.

5. ANALYSIS

(252) The following section describes the processing and analysis of the Dealey Plaza photographic evidence undertaken by the Photographic Evidence Panel. Each of the major subdivisions of this section contains a synopsis of the issues in question, a summary of the relevant photographic evidence, and a discussion of the special processing operations used to enhance the evidence. The evidence in question is identified by using the photographer's name—for example, a motion picture taken by Orville Nix will be referred to as the Nix film. In the

---

[1] In general, a minimum requirement was that the material be original and transparent film. See pars. 39–41, *supra*.

[2] A list of the most important photographic materials reviewed by the Panel is set forth in par. 42, *supra*.

[3] See pars. 9–38, *supra*.

case of multiple pictures by the same photographer, frame numbers are also used.*

(*a*) *The Texas School Book Depository*

(253) Evidence from sources other than phototgraphy led the Warren Commission to conclude that the shots that struck the President had come from an open window on the sixth floor of the Texas School Book Depository. (*82*) Several sources of photography exist that show the window before and after the fatal shots. These were examined for evidence of a gunman.

(254) The following photographs of the Texas School Book Depository were subjected to image enhancement:

(1) The Dillard photographs (2).
(2) The Powell photograph.
(3) The Hughes motion-picture film.

(255) The Dillard and Powell photographs and Hughes film were taken from the region of the intersection of Houston and Elm Streets in Dealey Plaza. Dillard, a professional photographer, was riding in a press car in the Presidential motorcade. At the time he took his pictures of the Depository, the car was approaching Elm and Houston. (*83*) Powell was standing considerably to the right of Dillard, near the southeast corner at Elm and Houston, and his picture therefore shows the window from a much more oblique angle. (*84*) Hughes was standing near the southwest corner of Houston and Main Streets; (*85*) thus, his motion picture film was taken from a much greater distance than the Dillard and Powell photographs.

(256) The time at which the photographs of Dillard and Powell were taken is only approximate. Dillard stated that his second picture was taken a few seconds after the last shot that he heard. (*86*) Powell has estimated that he took his picture about 30 seconds after the last shot. (*87*) A shadow analysis performed by the panel confirmed that these photographs were taken at the same approximate time, with Dillard's first and Powell's second. (*88*) The Hughes film ended 2 to 10 seconds before any shots were fired, as indicated by the position of the Presidential limousine in the film.**

1. DILLARD AND POWELL PHOTOGRAPHS

(257) Examination of both the Dillard and Powell photographs of the sixth floor windows shows an open window with deep shadows in the region behind it. The deep shadows indicate the film was underexposed in these regions; that is, too little light reached the film for a clear recording of any details in the room behind the window.

(258) A number of enhancement processes were applied to the photographs in order to bring out any details obscured within the underexposed regions. They were as follows:

---

*This system has been used by others who have analyzed the evidence, including the Warren Commission and the commentators and critics of the Warren Commission.

**The panel did not consider it necessary to refine these estimates of the time of the taking of the photographs because it would not have helped to resolve the issue of whether these photographs depicted any gunmen.

(259) (*1*) Photographic enhancement (using photo-optical and photochemical techniques) of the underexposed regions of the Dillard photograph undertaken at the Rochester Institute of Technology (RIT). (*89*)

(260) (*2*) Autoradiographic enhancement of the underexposed regions of the Dillard photograph at Stanford Research Institute, Inc. (SRI). (*90*)

(261) (*3*) Computer enhancement of the underexposed regions of the Powell photograph at the University of Southern California and the Aerospace Corp. (*91*)

(262) In addition, the Dillard photographs were scanned and digitized for possible computer enhancement. Nevertheless, no such enhancement was performed because the Panel decided that the autoradiographic technique had more potential for success.

(263) The photographic and computer processes made visible details that had been obscured in the underexposed regions of the photographs. Both the photographic enhancement by RIT and the autoradiographic enhancement by SRI revealed a feature in the fifth floor window immediately beneath the sixth floor window. Figure IV–1 (JFK exhibit F–153) shows one of the original Dillard photographs, and figure IV–2 is an autoradiographic enhancement. The detail revealed by the processing appears to be a circular light fixture hanging from the ceiling of the fifth floor room, with a light bulb in the center of the fixture.*

---

*The Panel observed all enhanced images under optimum viewing conditions. Reproduction of the enhanced images for this report results in a degradation in quality. The Panel's decisions were reached on the basis of the image quality of the original enhanced photographs, and not on the quality of images as reproduced in this report. See par. 28 supra.

FIGURE IV-1.—Dillard photograph (unenhanced).

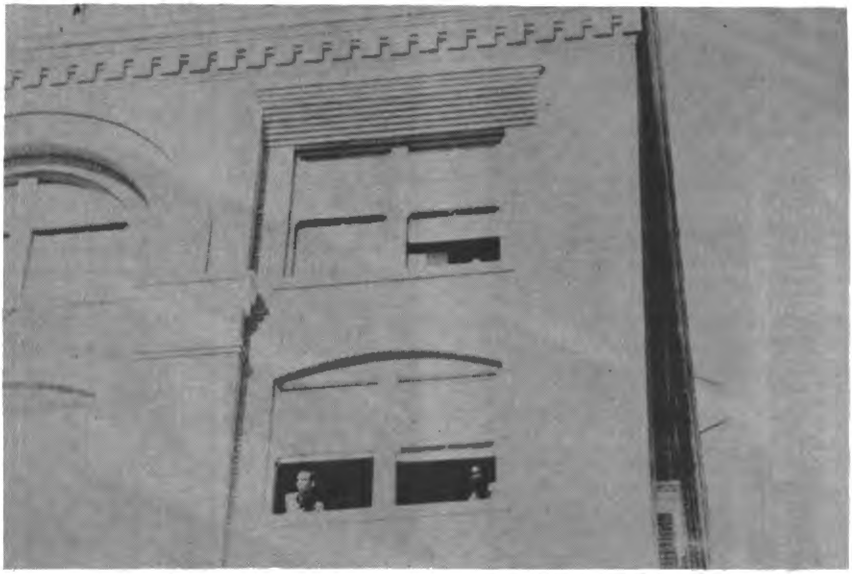


FIGURE IV-2.—Autoradiographic enhancement—Dillard photograph.

(264) In the enhanced Powell photograph additional details became visible on the boxes in the windows. (See figure IV-3, JFK exhibit F-157.) Nevertheless, in neither photograph did the processing operations reveal any sign of a human face or form in the open sixth floor or adjoining windows.

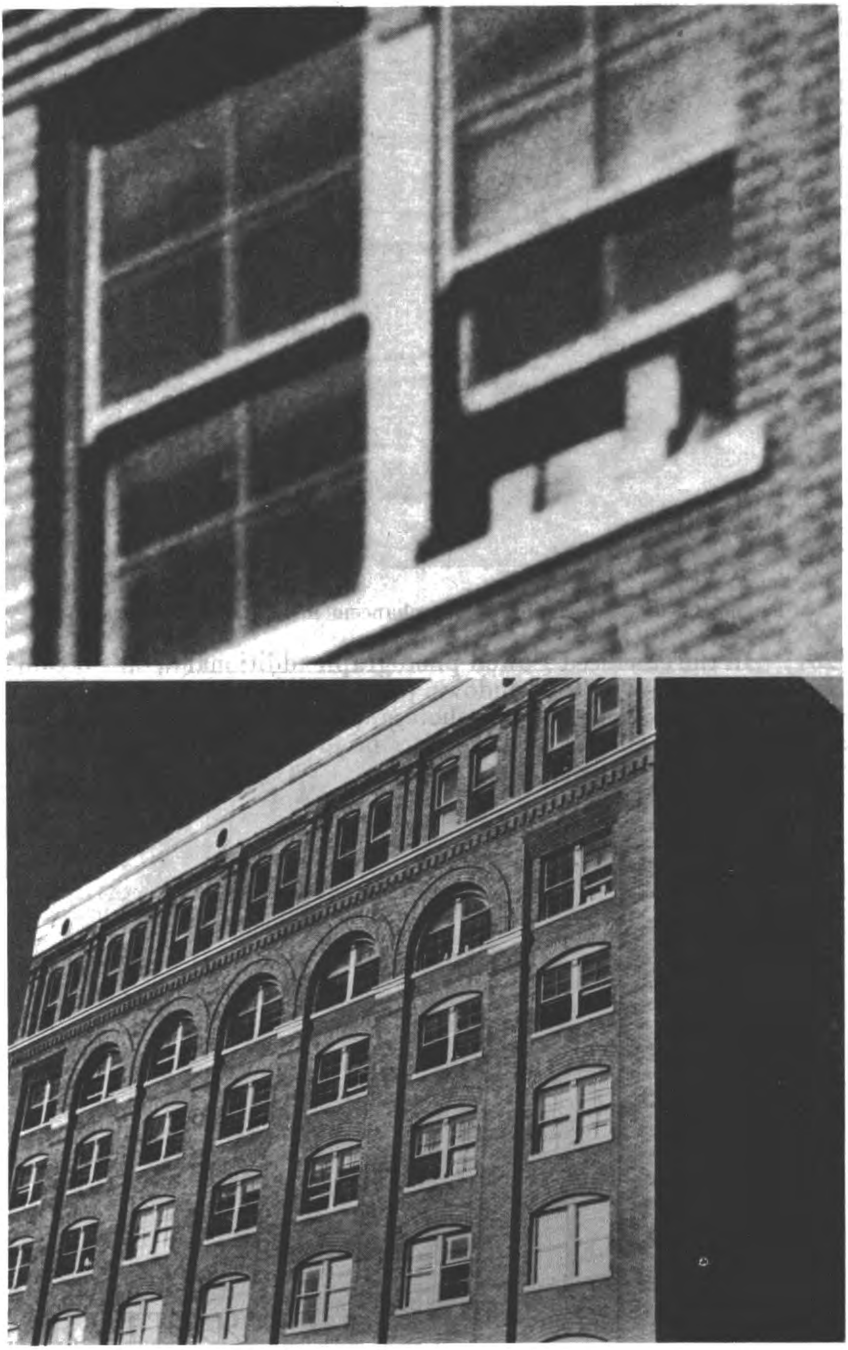


FIGURE IV–3.—Powell photograph. Top: Enhanced window area. Bottom: Unenhanced original.

(265) The Panel concluded that the light fixture revealed in the fifth floor window served as a "benchmark" against which the sixth floor enhancement could be judged. Accordingly, the enhancement of a recognizable object in the fifth floor window gave the Panel confidence in its judgment there were no recognizable human forms in the enhancement of the sixth floor windows.

(266) Although human faces or forms were not visible in the enhanced photographs, inspection of figures IV–2 and IV–3 reveals a difference in the boxes visible through the sixth floor widow. In the Dillard photograph, only two boxes are immediately visible, one each at the left and right of the window frame. Nevertheless, the Powell photograph shows several additional boxes. There are two possible explanations for this difference:

(267) (*1*) The Powell photograph may reflect only an apparent change in the boxes; the different angle from which Powell viewed the depository may have caused a different set of boxes within the room to be framed within the window;

(268) (*2*) The boxes were moved during the time that elapsed between the Dillard and Powell photographs.

(269) Since the precise positions of Dillard and Powell at the time of the photographs were unknown, it was not possible to calculate precisely the region within the sixth floor room that would have been visible to each photographer. In the Dillard photograph, the two boxes at the left and right of the window frame appear to be in the full light of the Sun, with no shadows cast on them by the frame of the partially opened window. In the Powell photograph, it also appears that the boxes are in full sunlight, with no shadow cast on them by the window frame.

(270) A simple trigonometric calculation shows that the two boxes at the left and right lie approximately 6 inches from the plane of the window (see addendum A). If full sunlight is falling on the additional boxes in question in the Powell photograph, they must also lie close to the plane of the window.* For this reason, the Panel concluded that the additional boxes visible in the Powell photograph were moved during the interval between the Dillard and Powell photographs.

(271) An additional issue relating to the sixth floor windows was the possible presence of a human face or form in the adjacent windows. None was found by the Panel.

2. HUGHES MOTION PICTURE FILM

(272) The Hughes film shows the Presidential limousine for a total of 88 frames as it is proceeding down Houston Street toward the Texas School Book Depository. The open sixth floor window of the depository is visible in the upper left corner of the film frames. An object, approximately rectangular in shape, is visible in the open

---

*If the additional boxes in the Powell photograph were so far back into the room that the difference in viewing angle made them apparent in the Powell photograph and not in Dillard's, then they would not appear to be in full sunlight. Since at the time of the assassination it was late fall, the midday sun was south of directly overhead and therefore would have been entering those windows of the Texas School Book Depository facing directly south.

window. When the film is viewed as a motion picture, the object distinctly appears to be moving.

(273) The 88 frames were processed for computer enhancement and motion analysis at the Aerospace Corp. (*92*) The scans were centered on the portion of the frames that showed the open sixth floor window and the closed windows adjacent to it. After scanning, the images were viewed on a precision television soft-copy video-display computer system that was used to adjust the contrast of the displayed images.

(274) Figure IV-4 (JFK exhibit F-121) shows a single unenhanced frame of the Hughes film. It was the judgment of the Panel that the object in the open window was partially in the Sun and partially in the shadows. This judgment is based upon the enhancement of selected frames of the Hughes film by computer contrast alteration.

(275) As the contrast of any single frame was changed by computer, the shape of the object in the open sixth floor window also changed. When an object is in both Sun and shadow and an exposure is chosen that will record the sunlit features, the shadowed features will be underexposed. A computer can be used to alter the contrast and correct for the underexposure so that the object within the shadows is more directly visible. In this case, however, the processing also changes the shape of the image.

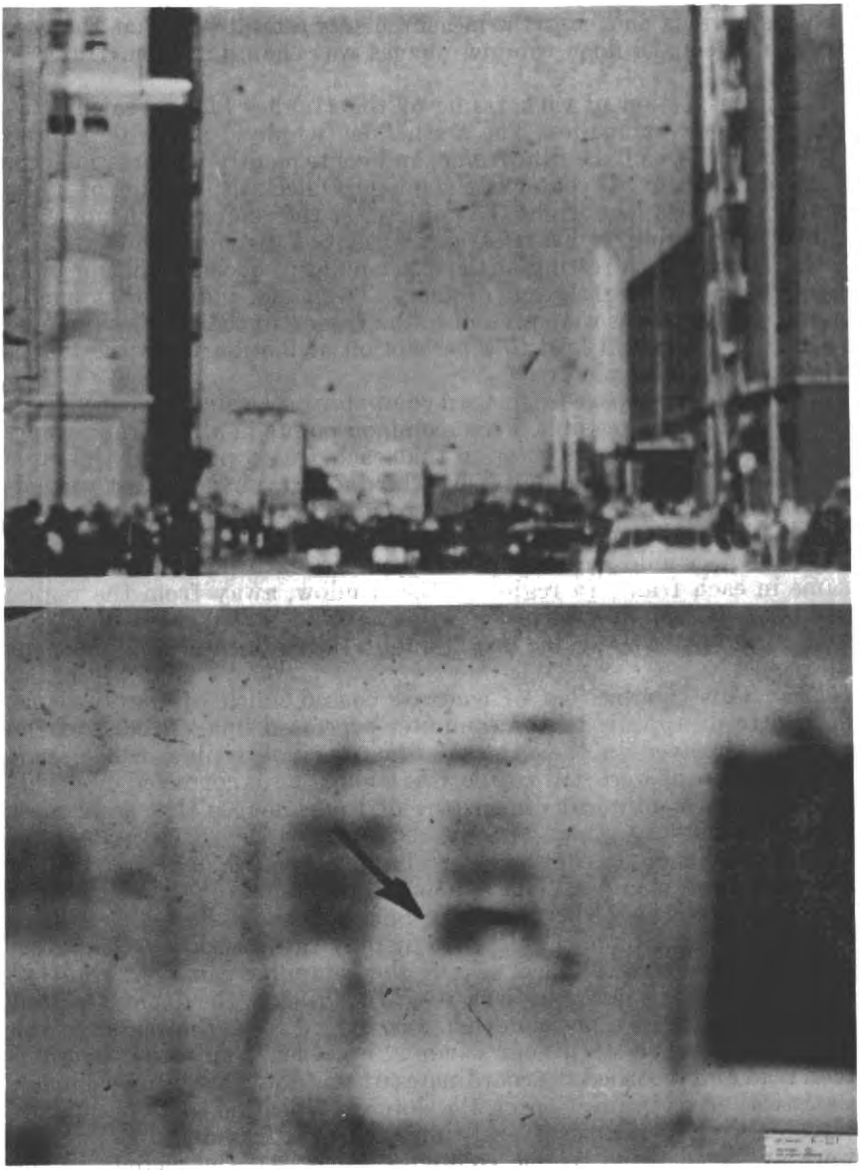


FIGURE IV–4.—Hughes film (unenhanced) Top: Full frame view. Bottom: Enlarged window area.

(276) It was theorized that the contrast of each frame of the unenhanced Hughes film was not constant in the region of the sixth floor window, and that this was causing an apparent change of shape that appeared to be motion in the film sequence. The panel used computer displays to inspect the 88 frames of the Hughes film without enhancement and computer calculations to measure the contrast. Both the vis-

ual inspections and contrast measurements established that the contrast of the sixth floor window images was changing from frame to frame.

(277) Inspection of each frame of the Hughes film revealed other photographic anomalies. The sixth floor window of the depository is near the edge of the film frame, and consequently it is less in focus than objects near the center of the image. Objects at the edge of a film frame were also less bright than objects at the center (a phenomenon called "vignetting"). Further, as film moved through the camera, it may not have been resting at the exact point of focus, resulting in an image that was slightly out of focus. The panel judged that one or more of these effects were present in the frames of the Hughes film and that they, too, could lead to a perception of motion when the film is viewed as a motion picture.

(278) The Aerospace Corp. used computer processing to reduce these effects as much as possible. First, common points in all 88 frames were "registered" in the computer so that each frame possessed the same coordinates in the computer. Next, the photographic contrast was adjusted to be as equal as possible between all frames. This was done by picking a bright point that was the same in each frame (the white edge of the windowsill was picked), and a dark point that was the same in each frame (a region in the window, away from the region of apparent motion, was picked). Each frame was then manipulated by computer so that all the bright and dark regions were the same for all frames.

(279) This equalization of contrast caused much of the apparent motion to disappear. In the computer-processed images, most of the motion perceived in the original film was not visible. Since some changes in focus were still visible, this anomaly was corrected by slightly altering the physical dimensions of those images that were most out of focus.

(280) The computer processing eliminated much, but not all, of the perceived changes. The extent of the remaining changes was quantified by using the computer image display at the Aerospace Corp. The operator of a computer display can position a computer-generated dot on the video screen; the computer can then read the coordinates of the dot onto the screen. In this case, the dot was placed by the operator at a position that was judged to be the center of the object in the open sixth floor window. For each frame, the computer then read and recorded the coordinates of this dot. To minimize human statistical error in positioning the dot, identification of the center of the object was repeated several times for each frame and the results were averaged. Finally, the computer calculated the change in the position of the center of the object from frame to frame.

(281) The results of this motion analysis can be seen in figures IV–5–6 (JFK exhibits F–159 and 159–A). Figure IV–6 shows the center of the object as determined by the motion of the dot. Each arrowhead position on the exhibit indicates the location of the center of the object for the particular frame number designated. The direction of the motion between frames can be discerned by going from each arrowhead to the next sequentially numbered arrowhead. The length of each arrow is proportional to the actual distance the center of the

object moved between frame identifications, and the thickness of each line is proportional to the amount of time (indicated by the decimal number) that it took to move that distance. Figure IV–5 shows the actual change in the shape of the object for frames 55, 56, 59, and 61.

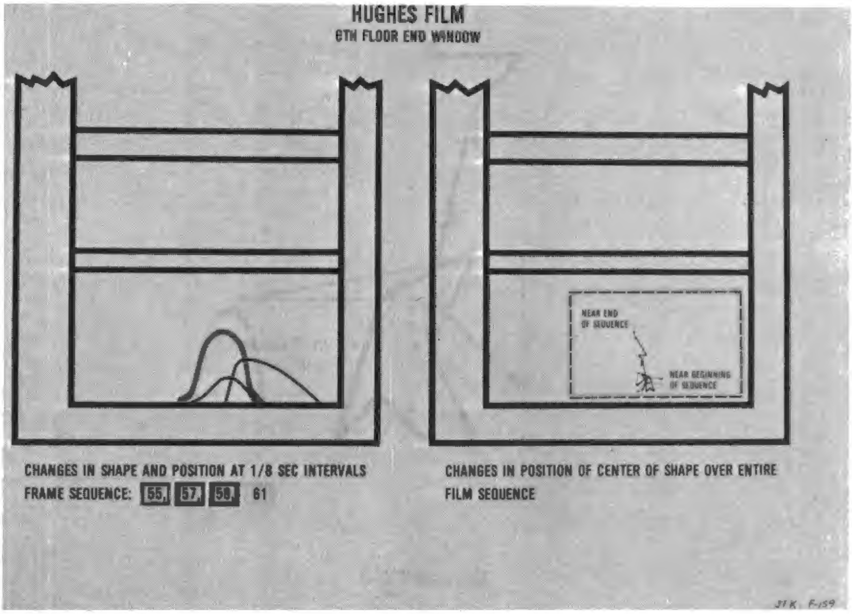


FIGURE IV–5.—Hughes Motion Analysis Diagram.

(282) The Panel interpreted these exhibits as demonstrating that the perceived motion was apparent rather than real. This conclusion was based on the following considerations:

(283) (*1*) The pattern of motion does not display a consistent direction, but appears to be attributable either to random motions or to purposeful, consistent motion of a very complex type;

(284) (*2*) When the time interval between positions is considered, the motions appear to be quite rapid. For example, motions of 18 inches per second can be calculated. While such rapid motions are not impossible, they are considered improbable when considered along with the complexity of the motion as revealed in figure IV–6.

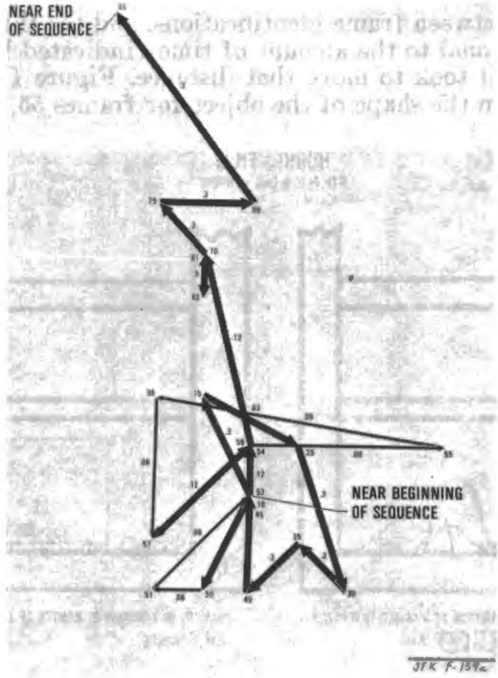


FIGURE IV-6.

(285) *(3)* In one two-frame sequence, the object disappeared: It is present in frame 59, but not in frame 60, and then is visible again in frame 61. This abrupt disappearance and reappearance is not consistent with human motion and can be explained only as a photographic anomaly.

(286) In summary, a pattern of changes in the object in the sixth floor window is visible in the computer processed images of the Hughes film. Nevertheless, the Panel did not attribute this pattern of changes to the motion of any recognizable object such as a person. While the overall pattern of changes is not necessarily inconsistent with human motion, the Panel still concludes that the perceived motions are attributable to photographic artifact.

(287) The closed sixth floor windows adjacent to the open sixth floor window were also examined. The same type of artifacts were present.

BRONSON MOTION PICTURE FILM

(288) The original 8 millimeter movie film of the Texas School Book Depository taken by Charles L. Bronson a few minutes before the assassination was not made available to the committee until December 2, 1978. At that time, it was reviewed by several of the committee's photographic contractors and members of the Photographic Evidence Panel. Based upon this preliminary review, the scientists believe that, as in the Hughes film, the apparent motion in the sixth floor southeast corner windows seems to be random and therefore is not likely to have been caused by humans. Nevertheless, no firm conclusion could be

reached without applying digital image processing, which was not possible because of time and money constraints. The Panel suggests that the good quality of this film makes it advisable that image enhancement be considered (possibly by the Department of Justice) if further investigative efforts are undertaken. (*93*)

(*b*) *The grassy knoll*

(289) To the right of the Presidential limousine as it proceeded down Elm Street in Dealey Plaza is a small knoll. An assortment of trees, bushes, and concrete works is located on it. Several persons present in the plaza at the time of the assassination stated that they thought shots were fired from the region of this knoll, (*94*) and commentators and critics of the Warren Commission have asserted that there is photographic evidence that supports the claims of a gunman firing from the area (*95*).

(290) The following photographic evidence pertaining to the grassy knoll was subjected to enhancement:

(1) Willis No. 5 photograph;
(2) Moorman No. 2 photograph;
(3) Nix motion picture film; and
(4) Zapruder motion picture film.

(291) The Willis No. 5 photograph was taken from the south side of Elm Street, near the intersection of Houston and Elm Streets. (*96*) The Moorman picture was taken from a point on the south curb of Elm Street, midway between Houston Street and the exit from Dealey Plaza. (*97*) The Nix film was taken from the other side of Dealey Plaza near the intersection of Main and Houston Streets. (*98*) Zapruder was standing on a concrete abutment by the retaining wall in the grassy knoll area (*99*).

(292) The Zapruder and Nix films span an interval that includes the fatal shot to the head, and therefore no ambiguity as to the time they were taken exists. The time at which the Willis and Moorman photographs were taken is, however, difficult to establish. From the position of the President and Mrs. Kennedy in the limousine in the Moorman photograph, the Panel believes that the photograph was taken at the time of the fatal head shot, corresponding with frame 313 of the Zapruder film.* The Willis photograph appears to have been taken several seconds earlier, at approximately Zapruder frame 202.

1. THE WILLIS PHOTOGRAPH

(293) Preliminary visual inspection of the Willis photograph showed extensive blurring of all features of the picture near the retaining wall on top of the grassy knoll. The blurring is most clearly seen in the freeway sign, which is in the line of sight between the retaining wall and the Willis camera. (See fig. IV–7, JFK exhibit F–155.) It was caused by motion that was complex and not uniform over the entire image. The Panel judged that the motion was probably a combination of rotation about a point to the lower left of the optical axis, and that a component of linear translation (that is, motion in a straight line) in the motion was also possible.

---

*Zapruder frame numbers are used as the basic time references because this film spans the most comprehensive interval of time. See par. 146, *supra*.

FIGURE IV-7.—Willis No. 5 photograph (unenhanced).

(294) The Willis photograph was scanned for possible input into a computer. Since it is in color, the scan had to be a full-color scan. Then the knoll area from the scan was presented on a full-color computer video display. The display and manipulation were performed at the University of Southern California. *(100)*

(295) The retaining wall at the top of the knoll was subsequently enlarged by a computer operation similar to enlargement by photo-optical and photo-chemical techniques. This computer display made visible an object whose size and shape were consistent with a human being, positioned just inside the retaining wall. (See fig. IV-8, JFK exhibit F-160.) The object possessed colors with a distinct resemblance to flesh tones, as revealed on the color display. The Panel perceived the object to be that of a badly blurred image of a person, dressed in dark clothing, standing or leaning just inside the retaining wall.

FIGURE IV-8.—Willis No. 5. Wall Image Enhancement.

(296) Since the image was badly blurred, an attempt was made to use the computer to remove the blur. Blur removal can be accomplished if its extent is not too great. (*101*) Unfortunately, the image was so severely degraded in the region of the retaining wall that deblurring efforts were not successful.

(297) The next computer processing step was to make measurements of the color values of the object behind the retaining wall in order to compare the perceived flesh tones with those of a person at another location in the Willis photograph. The photograph was scanned in color: Separate measurements were made of the three primary colors, red, green and blue, from which other colors can be made.

(298) After scanning, an image analyst at the Aerospace Corp. viewed the image on a color video image display and positioned a computer-generated dot at those points where colors were to be measured. The computer then recorded the red, green, and blue values in the image at the dot's positions. A similar analysis was carried out at the University of Southern California.

(299) Regions measured at the Aerospace Corp. included the flesh tones of the object near the retaining wall and of Marilyn Sitzman, the secretary to Abraham Zapruder, who is visible in the Willis photograph. Sitzman's flesh tones were measured both in shadow and sunlight. At the University of Southern California, flesh tones were measured for the object at the retaining wall and for several people: A policeman, a bystander, and a child. In addition, measurements were made of Mrs. Kennedy's hat, which was pink in color and had a flesh tone appearance on the video display. (*102*)

(300) The Aerospace Corp. measurements showed the flesh tones of the object near the retaining wall to be comparable to the known flesh tones of Zapruder's secretary. USC's measurements also showed similarity between the flesh tones of the object and those of known persons; however, the similarities were not as strong as those found by Aerospace. The measurements of Mrs. Kennedy's hat were found to be distinguishable from the measurements of known flesh. Nevertheless, the differences of Mrs. Kennedy's hat from known flesh measurements were only marginally greater than differences of flesh tone measurements from each other. (*103*)

(301) Based on these measurements, as well as visual analysis, the Panel concludes that the object was most probably an adult person standing behind the wall. First, the general shape and structure of the object, including the location of the flesh tones, appear to be human. Second, the height of the object in relation to the known height of the wall is consistent with that of an adult of average height (5′6″ to 6′ tall). Third, the measured values of the flesh tones of the object are comparable with those of people in the photograph. Fourth, an additional Willis photograph, No. 6, taken after the Presidential limousine had exited Dealey Plaza but showing approximately the same field of view as No. 5, no longer shows the object near the retaining wall, or anywhere else; it has disappeared. (See fig. IV–9.) The mobility of the object greatly increases the likelihood of its being a person.

FIGURE IV–9.—Willis No. 6 photograph.

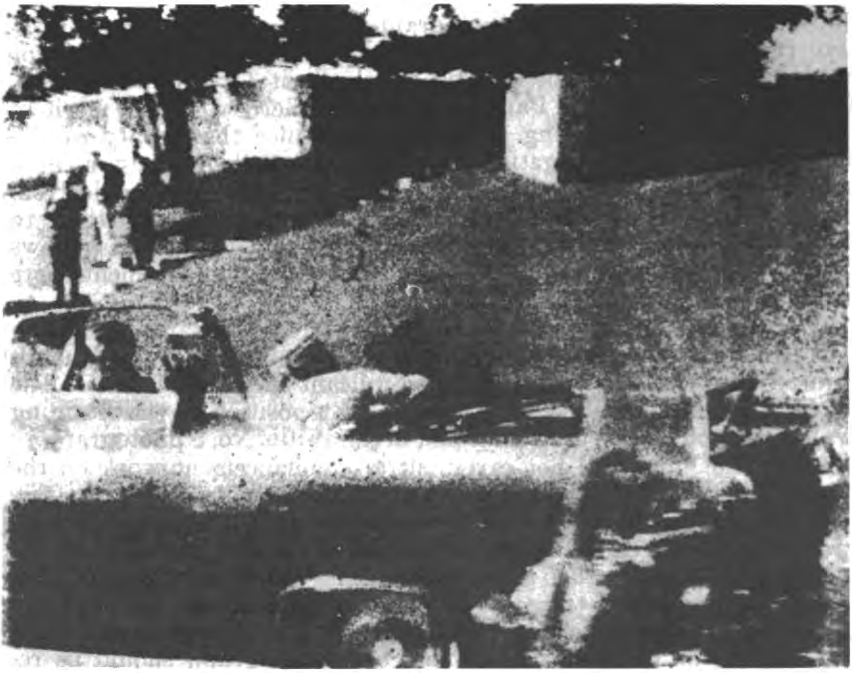


FIGURE IV–10.—(JFK exhibit F–129) Moorman No. 2 photograph.

(302) Since the panel concluded that the object was probably a person, the next question was whether there was any evidence of a weapon associated with this individual. Visible near the region of the hands is a very distinct straight-line feature extending from lower right to upper left. The panel notes, however, that the image is badly blurred in this region and that the direction of the blurring is the same as the southeast-northwest orientation of the linear feature near the hands. The blur would stretch any small point object on the wall into a linear object. As the blur could not be clarified, the panel could reach no conclusion as to the existence of a rifle or any other weapon in relation to the person standing behind the retaining wall.

2. THE MOORMAN PHOTOGRAPH

(303) The Moorman No. 2 photograph is a black and white Polaroid print that has suffered from handling during the intervening years. A number of large and small defects were visible on the photograph when the panel examined it. It, too, shows the grassy knoll and the retaining wall in the same region where the person was identified in Willis No. 5. (See fig. IV–10, JFK exhibit F–129.) It also shows another region of the knoll which critics of the Warren Commission have identified as important: The stockade fence. This fence runs toward the railroad overpass from the region of the retaining wall. Various critics have claimed that gunfire was directed at the President from behind the fence. (*104*) Finally, this is the area from which the committee's acoustics analysis indicates a shot originated. (*105*)

(304) Since the Moorman photograph is opaque rather than a negative transparency, a conventional image scanner (one designed for transparencies) could not be used to sample it for computer input. Given its condition, the Panel judged that there was little merit to using computer processing. Instead, to enhance the quality of the image, a high-quality negative copy was made at the Rochester Institute of Technology. A series of photo enlargements was made from this negative. The contrast and brightness were altered in these to bring out any objects or details that might be visible in the shadows or underexposed regions. (*106*) These photographic enhancements were focused on the region of the retaining wall.

(305) These efforts were not successful. The Moorman photograph was so underexposed in the region of the retaining wall that the alterations in contrast produced no significant increase in detail. The Panel could find no evidence of a person in a position on the retaining wall corresponding to that identified in the Willis No. 5 photograph.

(306) The Panel did not carry out any enhancement work on the Moorman photograph in the area of the stockade fence because this area was judged to be of even lesser quality than the retaining wall area, which had yielded negative results. This decision, however, as well as the decision not to apply digital image processing to this item, was made long before the committee's acoustics analysis was finalized. Although it is extremely unlikely that further enhancement of any kind would be successful, this particular photograph should be reexamined, in light of the findings of the acoustics analysis.

3. THE NIX FILM

(307) The final photographic source relating to the grassy knoll retaining wall is the Nix motion picture film. Several frames coinciding with the fatal head shot frames of the Zapruder film were selected for scanning and input into the computer. The scanning was performed at the Los Alamos Scientific Laboratory; the scanned data was then sent to the Aerospace Corp. for enhancement by computer. The mode of enhancement was an edge and detail sharpening process that has the effect of making the photograph appear more in focus. (*107*) Fig. IV–11 (JFK exhibit F–161) shows both original and enhanced images of the Nix film, centered around the region of the retaining wall.

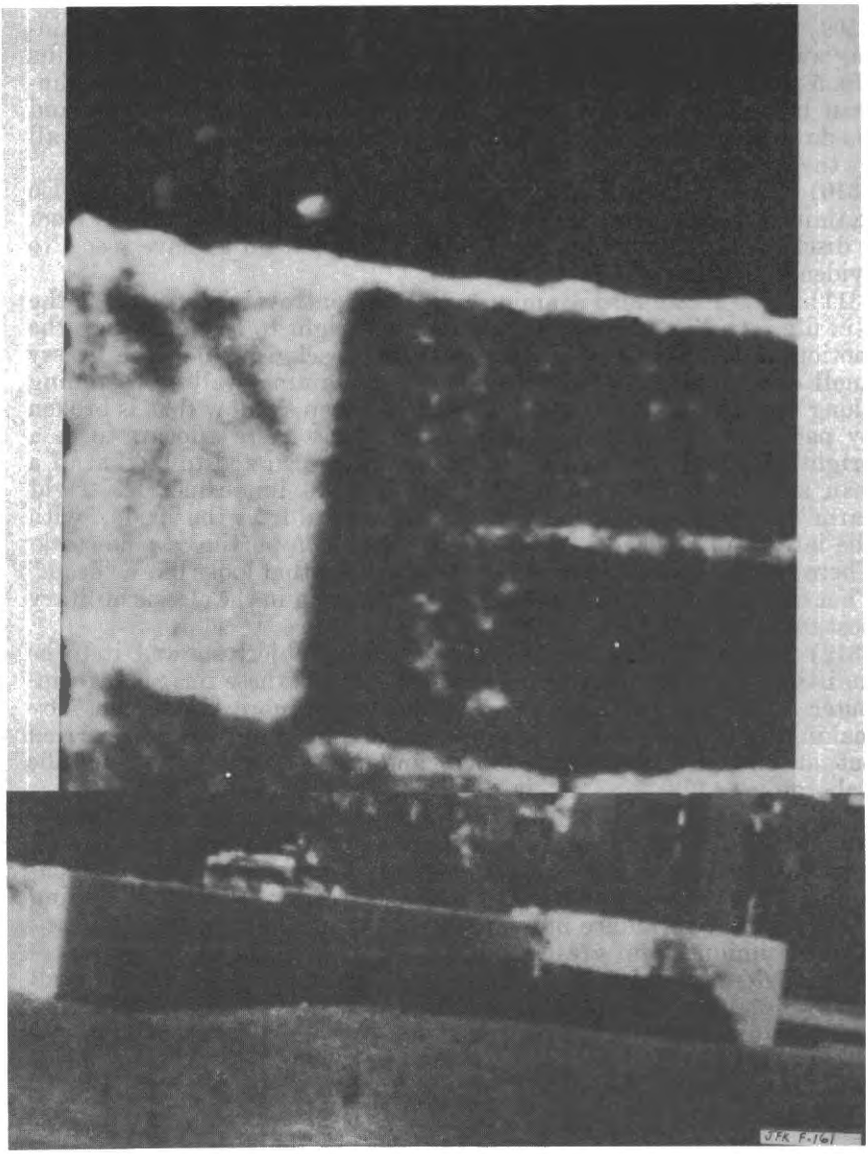


FIGURE IV-11.—Retaining wall image (Nix film) Top: Enhanced. Bottom: Unenhanced.

(308) The enhanced Nix film shows an object that can be construed as having a shape similar to that of a person. It is also possible to interpret this object as being of the same general shape as the person identified at the wall in the Willis No. 5 photograph. Nevertheless, the person in the Willis photograph displayed distinct flesh tones in the computer display of the image. No such pattern of flesh tones is visible in the enhanced (or original) Nix frames.

(309) The Panel could not conclude that the object near the retaining wall in the Nix film was the same as the person visible in the Willis No. 5 photograph. This image was not identified by the Panel as a human being. It was more likely the result of a pattern of light and shadows cast on an object in the background behind the retaining wall by the nearby trees.

(310) The area of the retaining wall image in the Nix frames was also examined for the presence of a flash of light or a puff of smoke from a discharging rifle, which some bystanders claimed to have seen. No evidence of either was found.

(311) The Panel also examined another controversial aspect of the Nix film. As Nix panned his camera from right to left following the motion of the Presidential limousine, the background of the grassy knoll came into view. In it, beyond the retaining wall and running along the crest of the knoll, is a region of deep shadow that is broken by patches of light. For a number of frames there appears to be a brightly lit object whose shape some have interpreted to be that of a man sighting a rifle toward the Presidential limousine. The right "arm" of this object is rigidly extended outward from the "body," with the left "arm" tucked in more tightly, as if supporting a rifle stock. There is, between and above these arms, a shape that looks like a "head." That object has been interpreted to be a rifleman in the classic military posture for firing a rifle. (*108*)

(312) Magnification of the classic gunman object showed it to be indistinct and blurry. It was decided to process these images by computer techniques that would bring the image more "into focus" by making its features sharper. Computer enhancement work was carried out at both the Aerospace Corp. and the Los Alamos Scientific Laboratory. (*109*)

(313) It was recognized that the limitation on improving the images would be the noise in the frames. Since several frames showed the region in question, it was decided to apply a "frame-averaging" technique. This process involves registering the frames and then adding them together to reduce noise, then enhancing the resulting product. This technique can greatly improve the quality of an enhancement. (*110*) Aerospace applied an enhancement process to the individual frames identical to the one applied to the Nix film for the person-at-the-retaining-wall image (see fig. IV–12, JFK exhibit F–163); (*111*) Los Alamos Scientific Laboratory applied a more sophisticated technique known as MAP restoration. (*112*)

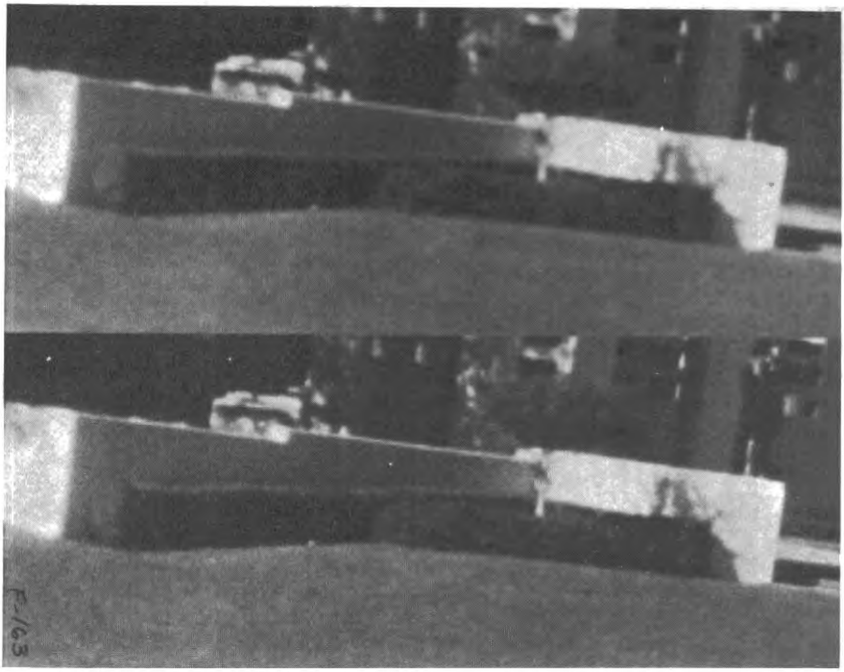


FIGURE IV–12.—Classic gunman image (Nix film) Top: Unenhanced. Bottom: Enhanced.

(314) Figure IV–13 (JFK exhibit F–162) shows the original and enhanced version of one Nix frame as produced at the Los Alamos Scientific Laboratory; the original is shown at the top, the enhanced version at the bottom. A total of eight frames were registered, added and enhanced to produce the lower image. Eight frames, considered to have the least blur or noise, were selected.

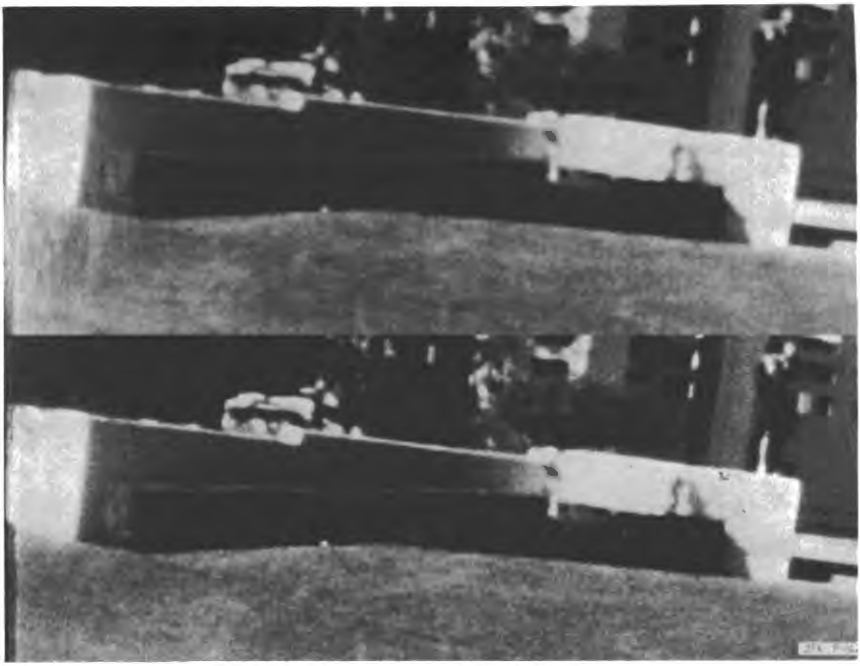


FIGURE IV–13.—Classic gunman image (Nix film) Top: Unenhanced. Bottom: Enhanced.

(315) After examining the enhanced image, the Panel concludes that the so-called classic gunman object was not a gunman. First, there is no evidence of human flesh tones in the "head" and "hands"; whereas the people in the Nix film have distinct flesh tones, the object here is almost uniformly white. Second, the white tones are identical in appearance with the white tones of the light regions of the shadow patterns cast on the wall of the structure behind the retaining wall by sunlight filtering through the nearby trees. Third, in the enhanced image, the shadow pattern above and to the right of the object is seen to be connected to the object itself.

(316) The Panel concludes that the most probable explanation is that the image is a chance pattern of sunlight on the structure behind the retaining wall. The Panel's conclusion was strengthened by an observation at the Aerospace Corp. that in one frame the "right arm" of the object disappears, only to reappear in the next frame. Such behavior would be virtually impossible for a person, but is conceivable for tree branches casting a shadow pattern on a wall.

(317) The Panel also examined the classic gunman object for evidence of a flash of light or puff of smoke. To enhance any phenomena as transient as these, the frames were differenced, that is registered frames were subtracted from each other sequentially in time. This technique makes transient phenomena highly visible. (*113*) No evidence of any flash or smoke was found.

(318) The Panel also reviewed a previous report by the Itek Corp. (*114*) Itek measured the relative displacement of the classic gunman in successive frames of the Nix film as the camera panned

from right to left. The extent to which an object shifts in successive frames can be used to calculate the distance from camera to object by applying the basic principles of photogrammetry. Itek calculated the distance from the camera to the object in this way and found that the calculations placed the object very near shelter 3 of Pergola 2 in Dealey Plaza. (*115*) Further study by Itek of the ground elevation in relation to the retaining wall showed that a line of fire toward Dealey Plaza would require that a rifle near this structure be 9 feet above ground. Itek concluded that the classic gunman object was a pattern of light and shadow on shelter 3. The Panel agrees with these conclusions.

4. ZAPRUDER FRAME 413—PHOTOGRAPHY OF ALLEGED HEAD IN THE BUSH

(319) When the Presidential limousine accelerated and pulled out of Dealey Plaza after the shooting, Zapruder continued to follow it with his camera. As the car passes him, going from left to right in front of him, a bush becomes visible in the lower right of the film frame, moving into the field of view from the right and traveling to the left as Zapruder panned the camera to the right. For a number of frames, an object that resembles a head is visible within the bush. In Zapruder frame 413 the object is very distinct and clear. Extending from the region of the head is a distinct linear feature. Critics have claimed that this linear feature is a rifle and that the head is of a gunman hiding behind the retaining wall and firing into Dealey Plaza. (*116*)

(320) The head in the bush is visible only in a few frames. From Zapruder's position on an abutment, which was connected to the retaining wall that lay to the right of the Presidential limousine (as it proceeded down Elm Street), his camera was the only one positioned so as to look through the bush and to the limousine in a geometry that shows the head, bush and limousine in the same line of sight. Zapruder frame 413, which shows the head object most clearly, was exposed approximately 5½ seconds after the fatal shot to the President's head at frame 313.*

(321) Since the head-like object is visible for several frames coming in from the right and moving to the left as the camera pans right, the Panel concluded that the object was real and not a chance arrangement of leaves. In frame 413, the head appears to be wearing a hat, such as a tennis hat, with a pulled-down brim. The "hat" is not visible in any other frames, however, and the Panel concludes that the "hatbrim" in frame 413 was only a coincidental juxtaposition of leaves near the head.

(322) Frame 413 was scanned for input to a digital computer at the Los Alamos Scientific Laboratory. (*117*) After scanning, the image was presented on a color video image display. The Panel again concluded that the object was a head. Flesh tones were visible on the back of the neck and ears. A hairline at the back of the neck was distinct and visible. The hair appeared to be fair in color; the head was either close-cropped or balding.

(323) Having found the object to be a head, placement of the head and bush in relation to Zapruder became of great importance. Placing the bush was simple because the Nix film shows Zapruder and the bush

*The time elapsed is readily calculated based on the camera framing rate of 18.3 frames per second.

in a series of frames. By using photogrammetric techniques, the USGS was able to place the Presidential limousine at the time of frame 413.(*118*) A line of sight drawn between Zapruder and the Presidential limousine passes directly through the bush, as seen in the survey map of Dealey Plaza (see fig. II–10, JFK exhibit F–133).

(324) To determine where the head lies on the line between Zapruder and the Presidential limousine, computer enhancement of frame 413 was undertaken at the Los Alamos Scientific Laboratory. (*119*) The image was processed by a technique that is designed to bring details into focus, the same technique used on the classic gunman frames of the Nix film. The result of the processing is seen in figure IV–14 (JFK exhibit F–164), where the original and enhanced images are displayed. From the enhanced image, measurements could then be made to determine the head location.

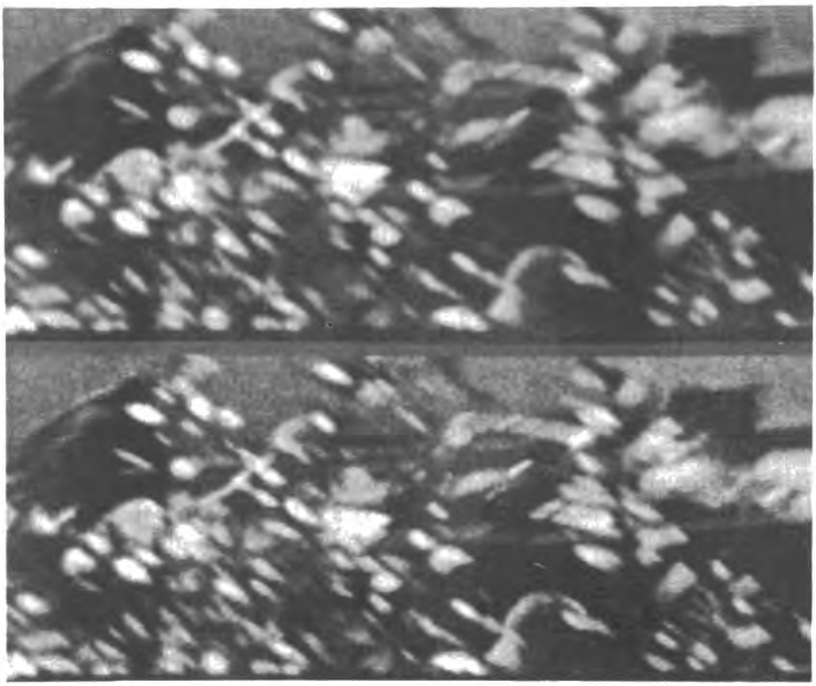


FIGURE IV–14.—Head in bush image. (Zapruder 413) Top: Unenhanced. Bottom: Enhanced.

(325) Accordingly, this photograph was then studied photogrammetrically. A basic principle in optics states that the size of an image is inversely proportional to the distance of the object from the camera that created the image.(*120*) Using this principle, the distance of an object from a camera can be calculated by comparing the size of its image to the image size of a similar object at a known distance. The size of the image of the head in the bush was compared to the size of the image of a head in the Presidential limousine. A simple calculation can determine where the head in the bush was located on the line of sight between Zapruder and the limousine (see addendum B).

(326) The head of the Secret Service agent climbing into the Presidential limousine was used for the calculation. Several measurements were made. The closest to Zapruder that the head in the bush can lie was in the middle of the sidewalk that runs from the top of the grassy knoll down to the street. The farthest away would be 10 to 15 feet beyond the sidewalk.*

(327) Based on this analysis, an inspection of the Dealey Plaza survey map (fig. II–10, JFK exhibit F–133) revealed that the head in the bush was not in the bush at all. The bush lies between Zapruder and head, with the head itself an appreciable distance away from the bush. Accordingly, there was no evidence of a person actually hiding behind the bush.

(328) Having located the head, the linear feature purported to be a rifle was examined. The computer-enhanced image shows a number of linear features similar to the one near the head, all extending in the same general direction as the alleged rifle. Further, close inspection of the enhanced image shows that the narrow part of the linear feature (the alleged "barrel" of the rifle) passes in *front* of leaves in the bush. Since the head lies far on the other side of the bush, it was geometrically impossible for an actual rifle barrel near this head to be situated in front of any leaves in the bush.

(329) The panel concluded that the linear feature was not a rifle barrel; it was only one of a number of twigs in the bush, all characterized by the same general direction and spacing in the natural growth patterns of the bush.

(330) Additional processing work was done at the Los Alamos Scientific Laboratory to study the region of the linear feature. (*121*) This processing, which was based on the knowledge that similar objects reflect light in similar ways, has been applied by NASA in analyzing satellite photographs of the earth for natural resources. (*122*) The technique developed by NASA is known as spectral ratioing and involves a comparison of color measurements by dividing measurements of the color values. (*123*) The objective is to compare the different amounts of red, green, and blue light reflected by an object. This is done by obtaining a computer scan of the photograph's red, green, and blue components and then measuring each one.

(331) When the Los Alamos Scientific Laboratory applied this spectral ratio technique to Zapruder frame 413, it found that the ratios in the region of the thick part of the linear feature (the "rifle stock") were identical to the ratios of the light reflected from the Presidential limousine. (*124*) On the basis, the panel concluded that the "rifle stock" was only a hole in the bushes looking through to the limousine, which, by virtue of being coincident with a twig, created the false impression of a rifle. Thus, no evidence of a gunman was discerned by the panel.

ADDENDUM A

Calculations on the Boxes in the Sixth Floor Window

(332) The boxes visible in the Powell photograph that were not visible in the Dillard photograph** appear to be equally in full Sun as

---

*See addendum B, par. 340 infra.

**Two relevant photographs were taken by Dillard. This analysis is based upon the closeup view depicted in fig. IV–2.

are those seen in the Dillard photograph.* This suggests that the additional boxes in the Powell photograph lie equally as close to the plane of the window as those visible in the Dillard photograph, ruling out the possibility of boxes very far inside the room being viewed by Powell from a viewpoint that was not available to Dillard. A simple calculation that can be used to place the two boxes visible in both Dillard and Powell shows that these boxes were very close to the plane of the window. This does not prove that the additional boxes in the Powell photograph lie equally close. Nevertheless, the appearance of being fully sunlit, without shadows from the window framing, strengthens the judgment that they do lie close to the plane of the window.

(333) Neither Dillard nor Powell had a camera angle perpendicular to the front of the depository building. Thus, they viewed objects in the windows from two different angles. As a convenient point of reference, the panel chose the triangular-appearing box corner that is visible in both the Dillard and Powell photographs at the lower right window frame. (See figs. IV–2 and IV–3.)

(334) The panel constructed the geometry seen in figure A–1 (infra). The diagram represents viewing angles from above the depository building, looking down, perpendicular to the horizontal plane of the street. The circular point a represents the corner of the box seen at the right of the windows; α and β are the angles made with respect to a perpendicular between point a and the plane of the window. (The plane of the window is assumed to coincide with the outer brick wall of the depository.)

(335) The angles α and β are not known precisely, since the exact positions of Dillard and Powell are unknown. They were crudely estimated in the following way. Dillard was riding in a press car behind the Presidential limousine; the position of the press car was approximately at the intersection of Houston and Elm when the picture was taken. Powell was on the east side of the intersection of Houston and Elm, and farther north than Dillard. Figure A–2 (infra) shows the approximate placement of the two photographers. The angles α and β shown in figure A–1 were measured from A–1 to be approximately 20° and 40°. It is important to note that these are only approximations. The imperfect knowledge of the locations makes it probable that there could be a $\pm 5°$ to $\pm 10°$ error in each angle.

(336) In figure A–1, the distance "d" is the apparent displacement of the corner of the box in position between the Dillard and Powell photographs. The distance x is the distance from true perpendicular (perpendicular is $\alpha = 0°$). The distance h is the distance behind the wall from which the corner of the box lies. It is measured from the box corner to the plane of the window.

---

*See par. 269 supra.

(337) From figure A-1, the following two equations can be formed:

$$\tan(\alpha) = \frac{x}{h}$$

$$\tan(\alpha+\beta) = \frac{x+d}{h}$$

Since α and β are known, assignment of a value to d allows the two equations to be solved for the distance h. Solving the equations for $\alpha = 20°$ and $\beta = 40°$ gives:

$$h = d/(\tan(\alpha+\beta) - \tan(\alpha))$$
$$= d/(1.37)$$

(338) The distance d is measurable as a fraction of the window width. The window was known, from the Warren Commission measurements, to be 36 inches wide. The shift d, when converted to a fraction of the width of the window, yielded $d \cong 8$ inches. Thus:

$$h \cong 5.8 \text{ inches},$$

or the box corner lay approximately 6 inches behind the plane of the window.

(339) While there are appreciable uncertainties in these calculations, the location of the boxes within 6 inches of the plane of the window is consistent with their apparent photographic position in full sunlight.

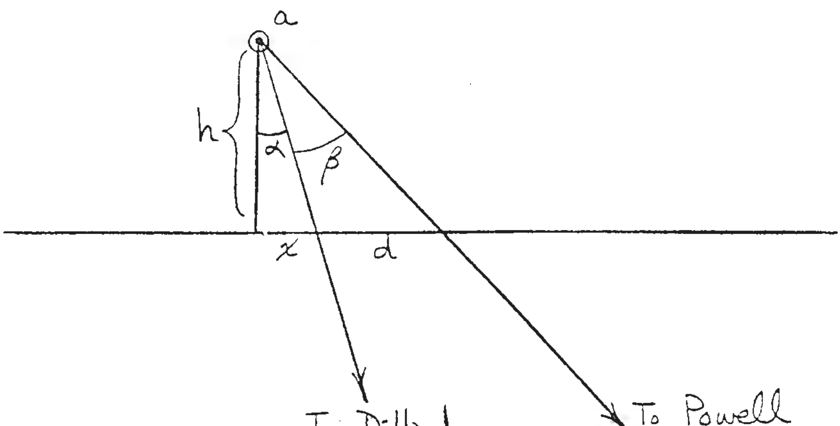
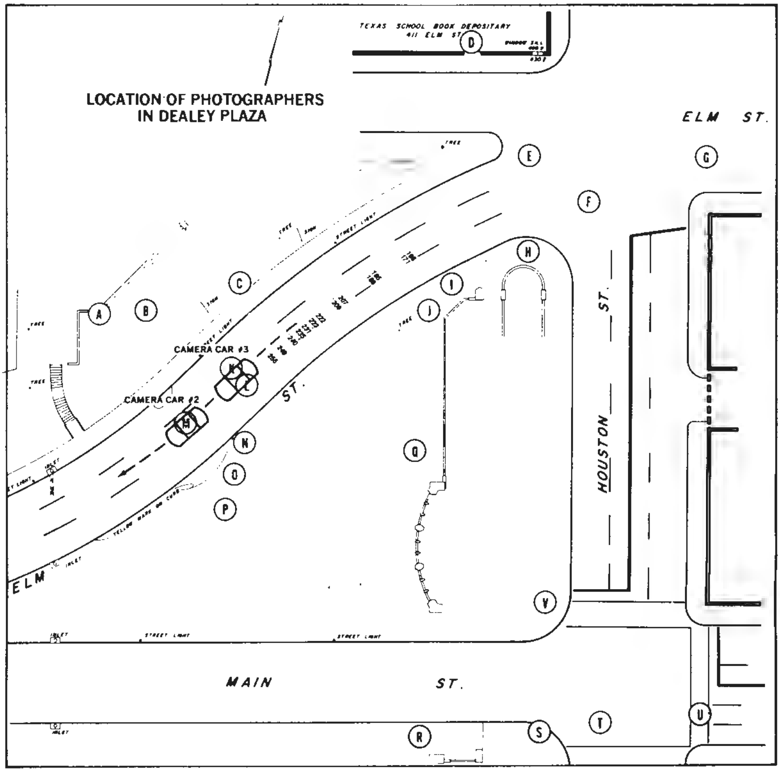


FIGURE A-1.—Viewing angles for Dillard and Powell photographs.



The twenty-two photographers in Dealey Plaza and where they stood.

A Zapruder (color movie)

B Cancellare (black & white still)

C Cablack (black & white still)

D Dorman (color movie)

E Weigman (black & white movie)

F Dillard (black & white still)

G Powell (color still)

H Martin (color movie)

I Willis (color still)

J Betzner (color still)

K Underwood (black & white movie)

L Couch (black & white movie)

M Rickerby (black & white still)

N Moorman (black and white Polaroid)

O Altgens (black & white still)

P Bothun (black & white still)

Q Muchmore (color movie)

R Nix (color movie)

S Bell (color movie)

T Hughes (color movie)

U Weaver (black & white Polaroid

V Bond (color still)

FIGURE A–2

Source: Courtesy of Josiah Thompson, author of "Six Seconds in Dallas."

ADDENDUM B

CALCULATION OF HEAD SIZES IN ZAPRUDER FRAME 413

(340) Figure B–1 (infra) shows the geometry of the objects and camera focal plane. Head No. 1 is located at distance r_1 and subtends an angle θ_1. Head No. 2 is located at distance r_2 and subtends an angle θ_2.

The common focal length is f. It was assumed that both objects are equally focused (or equally out of focus). The image sizes in the two cases are d_1 and d_2, respectively. It was also assumed that both heads have the same dimension d.

(341) Using the small-angle approximation:

$$r_1\theta_1 = d$$

$$r_2\theta_2 = d$$

Thus:

$$r_1\theta_1 = r_2\theta_2$$

and

$$\frac{r_1}{r_2} = \frac{\theta_2}{\theta_1} \quad \text{(A)}$$

(342) In the image plane, however, the same small-angle approximations give:

$$f\theta_1 = d_1$$

$$f\theta_2 = d_2$$

Thus:

$$\frac{\theta_2}{\theta_1} = \frac{d_2}{d_1} \quad \text{(B)}$$

Combining equations (A) and (B),

$$r_2 = \frac{d_1}{d_2} r_1 ,$$

This equation expresses the distance r_2 as a fraction of the distance r_1, the fraction being the ratio of the measured head sizes in the image. Thus, the key to estimating r_2 is to measure the ratio of head sizes.

(343) The measurement of the ratio of the head sizes is not simple because no other head in frame 413 is positioned the same as the "head-in-the-bush." Thus, it was necessary to make estimates of the head size of a person in the limousine. The estimation of head size is totally subjective as there was no analytical procedure to guide the estimates other than the obvious requirement that measurements of features be as comparable as possible for both heads. The width of the upper third of the head in the bush and the Secret Service agent climbing into the back of the limousine were measured because this portion of the head tends to be most spherical in shape, and hence, most invariant in size with respect to the viewing angle.

(344) The head in the bush, being nearest to the camera and largest in size, could be measured without appreciable error. The head of the Secret Service agent is partly obscured by leaves; therefore, three measurements were made corresponding to an estimate of the smallest head, the largest possible dimension, and a "best" guess. The measurements gave the following values for r_2:

$r_2 = .38r_1$, smallest estimate.
$r_2 = .44r_1$, "best" estimate.
$r_2 = .50r_1$, largest estimate.

(345) These figures can be used to place the head on the line of sight. For example, in figure II–10, the distance from Zapruder to the limou-

sine would be multiplied by the fraction 0.38, and the corresponding distance measured along the line from Zapruder. The smallest value places the head in the center of the sidewalk.

(346) There are possible sources of error in these calculations, but it is important to note that any errors would have to be substantial to place the head in the bush. For example, the ratio of head sizes that would place the larger head within the bush would have to be approximately 0.20; that is, nearly 50 percent smaller than recorded for the smallest estimate of the Secret Service agent's head. It is believed that the probability of errors of this magnitude is virtually zero. The placement of the head beyond the bush is a certainty. The placement of the head beyond the retaining wall is almost as certain, since the corner of the retaining wall would correspond to a ratio of head sizes of approximately 0.25.

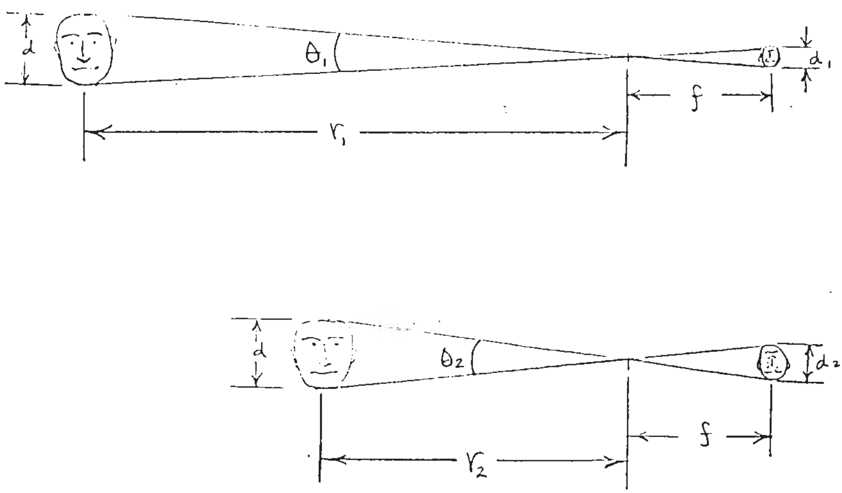


FIGURE B-1.—Head Size Calculation (Zapruder 413).

B. *Photograph Authentication*

1. THE OSWALD BACKYARD PHOTOGRAPHS*

(a) *Introduction***

(347) One of the most publicized questions to emerge in relation to the Kennedy assassination involves the authenticity of photographs showing Lee Harvey Oswald standing in his backyard, with a holstered pistol strapped to his waist, holding a Mannlicher-Carcano rifle

---

*This section prepared under the direction of C. S. McCamy and Cecil Kirk, with the assistance of David Eisendrath. For related public hearing testimony of McCamy and Kirk, Sept. 14, 1978, see HSCA–JFK Hearings, vol. II, pp. 349, 397.

**A glossary of terms is available in App. A of "The Backyard Pictures," Report to the House Select Committee on Assassinations by Dr. Leslie Stroebel, Mr. Andrew Davidlazy, and Dr. Ronald Francis, October 1978 (JFK Document No. 12902 [Hereinafter referred to as RIT Technical Report]). See par. 445 *infra*.

and two newspapers. These have become known as the backyard photographs.

(348) Oswald himself, when shown the pictures at Dallas police headquarters after his arrest, insisted they were fakes. Through the years, many critics have argued the same thing. In part, the controversy was stimulated by a 1964 Life magazine cover of a copy of one picture, retouched to enhance its quality.

(349) If the backyard photographs are valid, they are highly incriminating of Oswald because they apparently link him with the murder weapon. If they are fakes, how they were produced poses far-reaching questions in the area of conspiracy. "Faked" backyard photographs would indicate a degree of conspiratorial sophistication that would almost necessarily raise the possibility that a highly organized group had conspired to kill the President and make Oswald a "patsy."

(*1*) *History of the Backyard Photographs*

(350) In the early afternoon of November 23, 1963, Dallas detectives obtained a warrant to search the Paine residence in Irving, Tex., where Marina Oswald had been living. (*125*) The search concentrated primarily on a garage in which possessions of the Oswalds were stored. Among the belongings, Dallas police officials found a brown cardboard box containing personal papers and photographs, including two snapshots and two negatives of Oswald holding a rifle. (*126*) (Only one negative was made available to the Warren Commission; the other has never been accounted for.) (*127*)

(351) On the evening of November 23, 1963, Lee Harvey Oswald was shown an enlargement of one of the pictures. (That photograph was later designated by the Warren Commission as CE 133–A.) According to officers present, Oswald denied that he had ever seen the photograph and claimed that someone has superimposed his head on another person's body. Oswald was then shown the print (later designated as CE 133–B), which he also claimed was a trick photograph. (*128*)

(352) Marina Oswald was later questioned by the FBI about the photographs. She said that she had taken them in the backyard of the Oswald residence on Neeley Street in Dallas. (*129*) She gave, however, two different versions of when the pictures were taken. She first told the FBI it was in late February or early March 1963. (*130*) Her testimony to the Warren Commission reflected the same thing. (*131*) In an FBI interview made after her initial appearance before the Warren Commission, however, she said that the first time she saw the rifle was toward the end of March; she recalled having taken the photographs 7 to 10 days thereafter, in late March or early April. (*132*)

(353) Other evidence available to the Warren Commission supports her later version. A rifle and a revolver were shipped to Oswald from different mail order houses on March 20. (*133*) The left-wing newspapers Oswald is holding were dated March 11 and March 24 and were mailed on March 7 and March 21, respectively, both by second-class mail. According to postal authorities, both newspapers would have arrived in Dallas by March 28. (*134*) In addition, Marina claimed she remembered taking the photographs on a Sunday, about 2 weeks before Oswald allegedly shot at Gen. Edwin Walker on April 10. (*135*) From this information, the Commission deduced the likely date on which the photographs were taken to be Sunday, March 31, 1963. (*136*)

(354) In connection with the Warren Commission's investigation, Lyndal L. Shaneyfelt, an FBI photographic expert, performed an analysis on the two backyard prints designated CE 133–A and B, a negative, designated CE 749 (the original negative of CE 133–B), the Imperial Reflex duo lens camera (designated CE 750) that Marina Oswald testified she had used to take the pictures, (*137*) and the alleged assassination weapon (designated CE 139). His analysis and conclusions are as follows:

(355) (*1*) The photographs CE 133–A and B were taken with Oswald's Imperial Reflex Duo Lens camera. (*138*) Every camera has unique irregularities that are reflected on the margins of negatives made by it. Shaneyfelt determined that the margin irregularities of the original 133–B negative were identical to those of a negative that he exposed in the camera.

(356) Although he could not document absolutely the origin of CE 133–A because its negative was not available, Shaneyfelt concluded that both prints were taken with the same camera since they showed virtually identical background and lighting conditions. (*139*)

(357) (*2*) The backyard photographs CE 133–A and B are authentic. Shaneyfelt examined them under magnification and found no characteristics of compositing or retouching. (*140*) Initial public controversy regarding the authenticity of the backyard photographs arose after copies of CE 133–A, which appeared to differ in detail from the original photograph as well as from each other, particularly with respect to the configuration of the rifle, were published in Life, Newsweek and other news publications. (*141*) He testified that the apparent variations in the magazine versions were caused by retouching, a common practice in the reproduction of photographs for publication. (*142*)

(358) (*3*) The rifle in the backyard photographs is probably the rifle found in the Texas School Book Depository. Shaneyfelt photographed the rifle, attempting to duplicate the lighting and rifle's position in CE 133–A, and found the configurations matched those of the rifle in the backyard photograph. Although he found a notch in the stock of the rifle that appeared faintly on the rifle in the backyard photographs, he did not find enough peculiarities to state categorically that the rifles were identical. (*143*)

(359) Despite the Warren Commission's efforts to show that the backyard photographs were genuine, critics have persisted in doubting their authenticity. In general, the critics base their allegations of fakery on their observations of shadow inconsistencies, an indication of a grafting line between the mouth and chin, inconsistent head and body proportions, or a disparate square-shaped chin. (*144*)

(360) This position has received support from scientists who had not previously been associated with Warren Commission critics. For example, Malcolm Thompson, a British forensic photography expert, questioned in public the authenticity of the photographs in a 1978 British Broadcasting Corp. (BBC) television documentary. (*145*) At the request of the BBC, he had examined copies of the backyard photographs and concluded they were fakes.* Similarly, a photographic analyst with the Canadian Department of Defense reached the conclusion that these photographs were composites. (*146*)

---

*The text of a statement by Mr. Thompson is available in app. B to RIT Technical Report. See par. 445 *infra*.

(*2*) *Additional photographic evidence recovered by the House Select Committee on Assassinations*

(361) Marina Oswald, in addition to giving two different versions as to when the backyard pictures were taken, gave different versions of the number of pictures taken. At first, she testified she had taken one picture; (*147*) later she said it was two. (*148*) In addition, Marguerite Oswald testified that soon after the assassination she and Marina destroyed yet another picture in which Oswald was shown holding the rifle over his head with both hands. (*149*)

(362) The committee obtained an 8 x 10 print of an additional view of Oswald holding the rifle in a pose different from CE 133–A or B. This photograph, a first generation print,* was given to the committee on December 30, 1976 by Mrs. Geneva Dees of Paris, Tex. According to Mrs. Dees, it had been acquired by her former husband, Roscoe White, now deceased, while employed with the Dallas Police at the time of the assassination. (*150*) The panel designated this recently discovered photograph as 133–C (Dees).

(363) The committee obtained another first generation print of CE 133–A on April 1, 1977 from the widow of George de Mohrenschildt. (*151*) In the manuscript of his book, which he was writing at the time of his death in 1977, he stated that he and his wife had found the photograph in February 1967 among personal belongings they had stored in Dallas before departing for Haiti in May 1963. (*152*)

(364) Two additional first generation prints, one of 133–A and one of 133–C, where obtained from former Dallas Police Detective Richard S. Stovall on April 14, 1978. (*153*) Stovall was among the police officers who discovered the backyard photographs during the search of the Paine premises. (*154*)

(*b*) *Issue*

(365) Is there any evidence of fakery in the photographs of Lee Harvey Oswald that show him standing in a backyard holding a rifle in one hand and two left-wing newspapers in the other?

(*c*) *Materials and Procedures*

(366) The Photographic Evidence Panel examined Warren Commission exhibits CE 133–A and 133–B, the two backyard pictures seized from the Oswald residence by Dallas Police in 1963; CE 749, the original negative to CE 133–B, and CE 134, an enlargement of CE 133–A.** In addition to these Warren Commission exhibits, the Panel analyzed the four photographs recently discovered by the committee:

(367) (*1*) A photograph designated as 133A–de Mohrenschildt recovered from the estate of the late George de Mohrenschildt; (*155*)

(368) (*2*) A photograph designated as 133C–Dees, obtained from the Dees' widow; (*156*)

(369) (*3*) Photographs designated as 133A–Stovall and 133C–Stovall, obtained from Stovall. (*157*) (See fig. IV–15, JFK exhibit F–178, for a display of all of these photographic materials except CE–134, which is shown in fig. IV–22.)

---

*A first generation print is one made from the original negative.

**CE 134 was examined by two panel members after the final panel conference in July 1978.

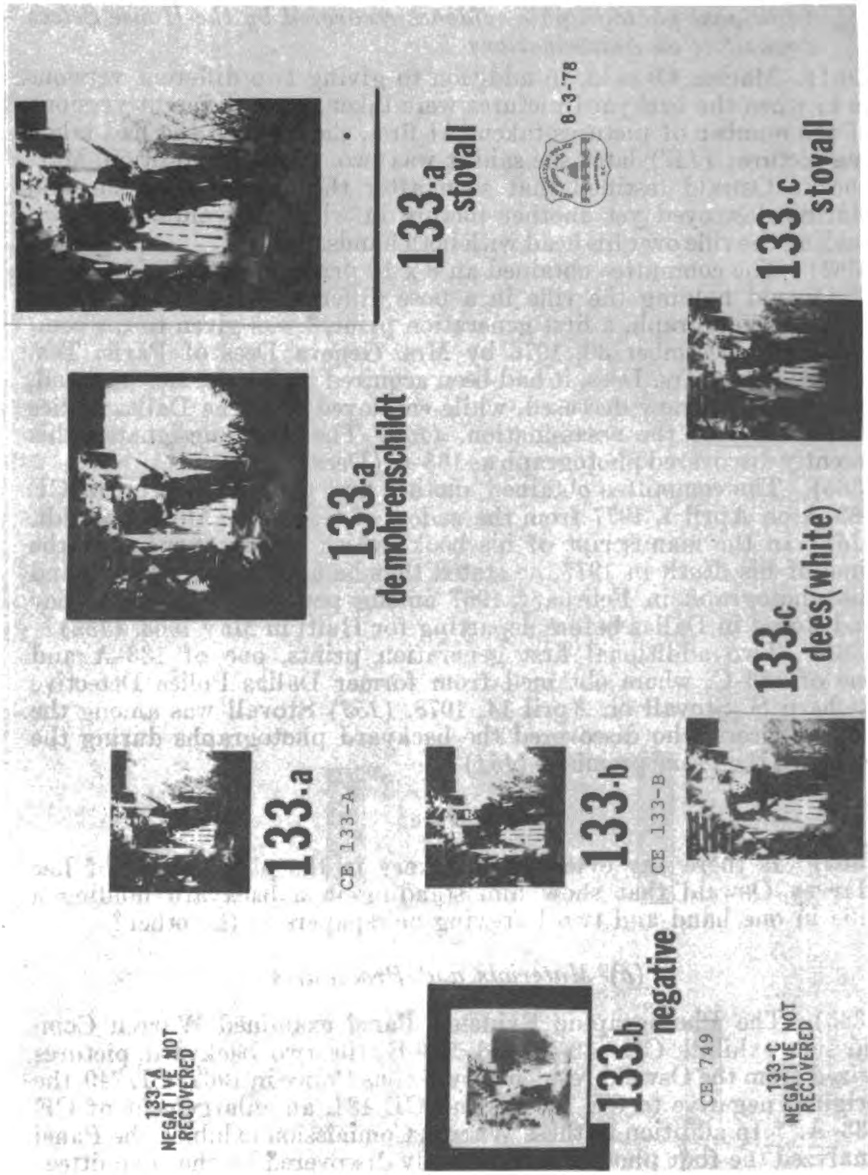


Figure IV–15.—Oswald "Backyard Pictures"—First generation prints and negatives examined by photographic evidence panel.

(370) These items were selected because of the Panel's policy of working just with first generation prints and original negatives. *(158)* Only these types of materials contain the most reliable photographic information; subsequent generation materials tend to lose detail in highlight and shadow areas, suffer deterioration of tonal quality, and are prone to include new defects that may impair the accurate representation of the photographic image. CE 133–A, CE 133–B, 133A–de Mohrenschildt, 133C–Dees, 133C–Stovall and CE 134 were identified

by the Panel as first generation prints. CE 749, the original negative to CE 133–B, was the only negative recovered from the possession of the Dallas Police Department; consequently, it was the only original negative available to the Panel for analysis. There is no official record explaining why the Dallas Police Department failed to give the Warren Commission the other original negative. (*159*)

(371) In addition to studying the various backyard picture materials, the panel examined CE 750, which was alleged to be Lee Harvey Oswald's camera (*160*) to determine whether it was used to take the backyard photographs. Next, the negatives and photographs were both visually inspected and compared with known photographs of Oswald. The panel's visual inspection included the use of magnifiers and microscopes. As an aid in this process, a series of enlargements at varying exposures and contrast ranges was made of CE 133–A and 133–B, thereby producing prints which ranged from very light to very dark. (See figs. IV–16 and IV–17, JFK exhibits F–192 and F–193.) The detail in the darkest parts of the pictures could be most clearly seen in the lighter prints. The details in the lightest areas could be most clearly seen in the darker prints. In this way, the panel had the best opportunity of detecting any evidence of falsification anywhere in the pictures.

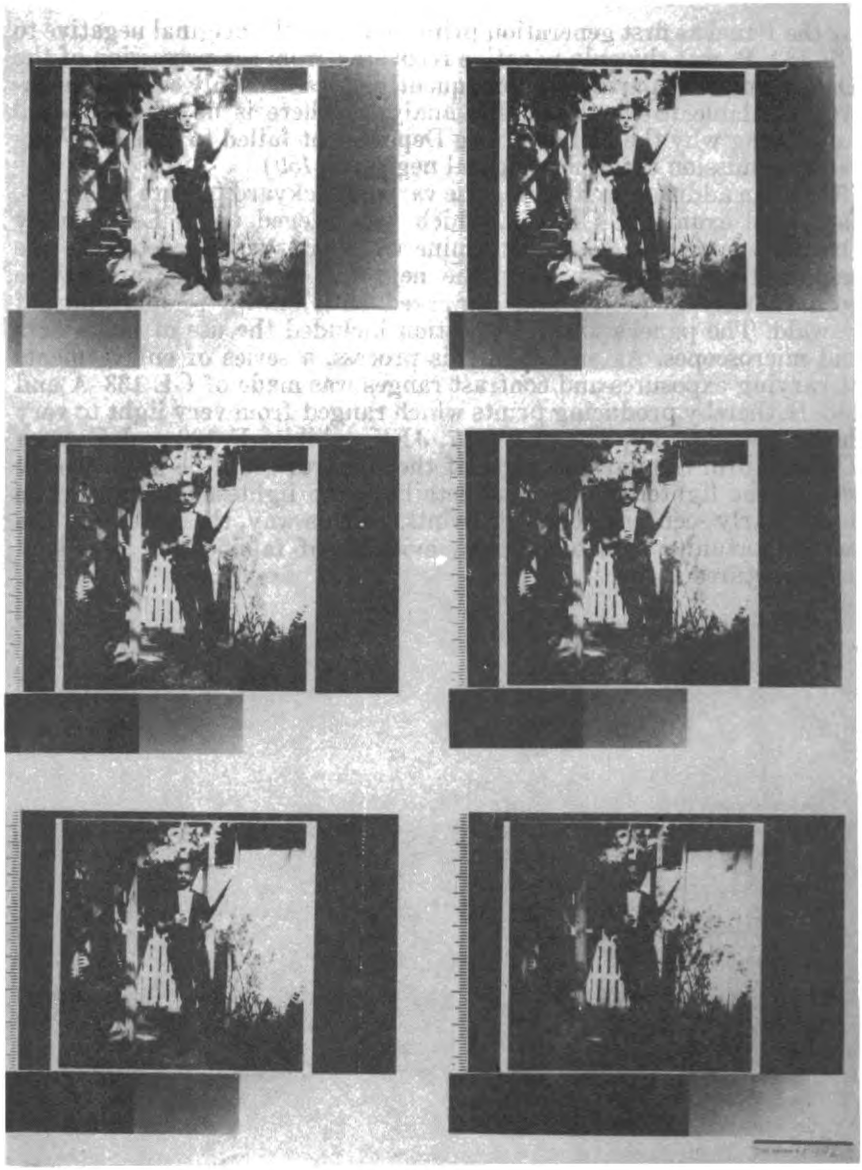


FIGURE IV-16.—CE 133-A printed at varying exposures and contrast ranges.

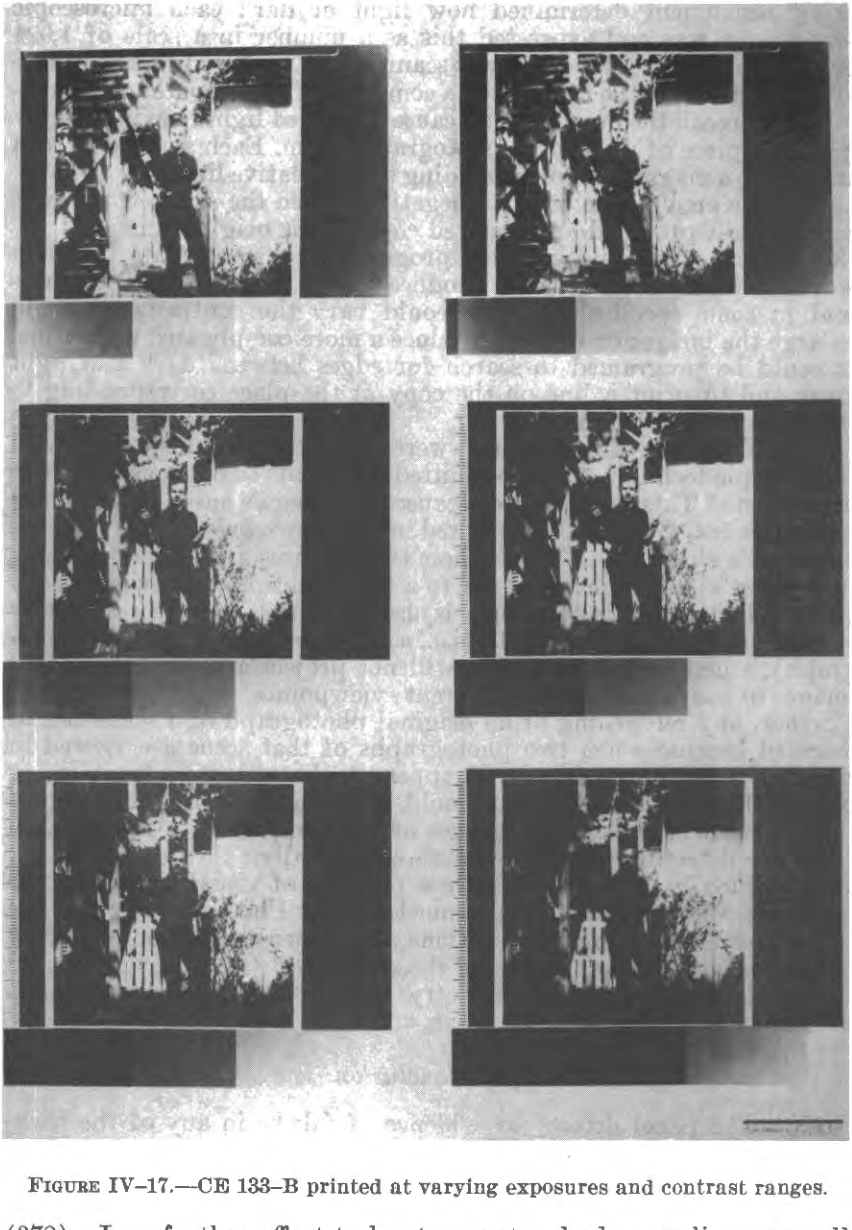


FIGURE IV–17.—CE 133–B printed at varying exposures and contrast ranges.

(372) In a further effort to locate unnatural edges or lines, as well as differences in grain structure and contrast variations, the panel used digital image processing.* The negative of CE 133–B was placed on a microdensity scanner so that light passing through the film could be measured. Such measurements were made on microscopic square areas that were positioned in a square-by-square pattern, but the actual squares were smaller than the silver grains on the negative. The meas-

*See pars. 16–34, supra.

uring instrument determined how light or dark each microscopic square area was and expressed this as a number in a scale of 1,024 grades of density. As the film was scanned, the number for each square area was stored in the memory of a computer. The computer could subsequently recall the numbers, and cause a beam of light to expose a tiny spot on a piece of unexposed photographic film. Each small area was exposed to a magnitude corresponding to the relative lightness or darkness of the area on the original negative. When the exposed film was developed, it provided an enhanced copy of the original image.

(373) The computer was also programed to manipulate the data stored in its memory. It could produce a copy different from the original in some specified way: It could vary the contrasts; it could enlarge the image; or it could produce a more complicated derivation. It could be programed to search for edges between dark and light areas and to print a line on the copy at the place corresponding to the edge on the original.

(374) The backyard pictures were also visually inspected with stereoscopic techniques that permitted the prints to be viewed in three dimensions.* This was possible because the camera's movement between exposures 133–B and 133–A resulted in two views, only a short distance apart, of a single scene. When these two pictures are viewed together in a stereo viewer, they give rise to a three-dimensional image. (*161*)

(375) This analytic technique is useful in the detection of fakery because photographs of prints (i.e., a photographic copy of a photograph), when viewed in stereo, will not project a three-dimensional image unless made from different viewpoints along one axis.** Further, any retouching of an original photograph of a scene can be detected because when two photographs of that scene are viewed in stereo, the retouched item will appear to lie either in front of, or behind the plane in which it should be lying. It is virtually impossible to retouch one or both images of a stereo pair with enough skill to escape detection when viewed stereoscopically.

(376) Finally, in addition to these methods of visual inspection, the materials were studied photogrammetrically. "Photogrammetry is the science of ascertaining the positions and dimensions of objects from measurements of photographs of these objects." (*162*) In the Oswald backyard pictures, photogrammetry was given particular emphasis in studying critical shadow areas.

(*d*) *Conclusion*

(377) The panel detects no evidence of fakery in any of the backyard picture materials.

---

*This principle of stereoscopy is discussed in pars. 76–78 *supra*.

**Identical photographs or photographs made from the same camera position will not generally exhibit stereoscopic characteristics. Nevertheless, if a camera is stationary and photographs of a subject that moves are viewed stereoscopically, the subject may exhibit three-dimensional properties, while the background will not.

(e) *Analysis*

(1) Production and development of prints

(378) The photographic prints examined by the panel were not of uniform size. These variations reflected differences in how each had been produced and developed. CE 133–A and 133–B were considered to be drugstore or photofinisher prints because they appeared to have been produced on the type of commercial photoprinting machine used by photofinishers for camera stores, drugstores and mass-produced prints.

(379) The photographs show a slight variation in the horizontal and vertical dimensions of the prints and borders that were caused by artifacts of masking position. On the back of each is the small graphite mark characteristic of automatic printing machines. It indicates to an electric eye scanner where the long continuous roll of prints should be cut into individual snapshots. (See figs. IV–18, IV–19, JFK exhibits F–179 and F–182.) As most drugstore prints, these were apparently cropped slightly for aesthetic purposes by placing a white border around their periphery. Finally, the panel noted that CE 749, the negative to CE 133–B, contained small emulsion tears, which indicated that it had been abused in processing, as well as water spots indicative of improper washing or drying.

(380) CE 133–A and 133–B were determined to be first generation because of the presence of very fine lines and marks that were occasioned either by scratches on the film, which were caused by the camera, or by torn or broken emulsion from the negative that occurred during development. Marks so fine and sharp would not have appeared with such definition on a second generation print.

(381) On review of 133A–de Mohrenschildt (see figs. IV–20 and IV–21, JFK exhibits F–382 (front) and F–383 (reverse)), the panel noted that it had been probably made in a high quality enlarger with a high quality lens. Nevertheless, the print has become yellowed with the passage of time, indicating that it was not adequately fixed or washed during the development process.

(382) The uncropped black border around the edge of this print indicates that it was projected in an enlarger with a negative carrier that was larger than the actual full size negative of CE 133–A. This type of equipment might be found in a graphic arts shop or photo printing shop that uses many sizes of negatives. It is also possible that the paper easel might not have had the capability of masking a print this size. As a result, the entire negative area is printed and the unexposed border area outside the full camera aperture has been recorded as black on the print. Because people normally like to have white borders on their pictures, this is an unusual way of presenting a photograph. The sharpness of the markings (from the film scratches) within this black border, as well as the presence of fine scratches and emulsion tears, indicates that this is a first generation print.

FIGURE IV–18.—CE 133–A and 133–B (front).

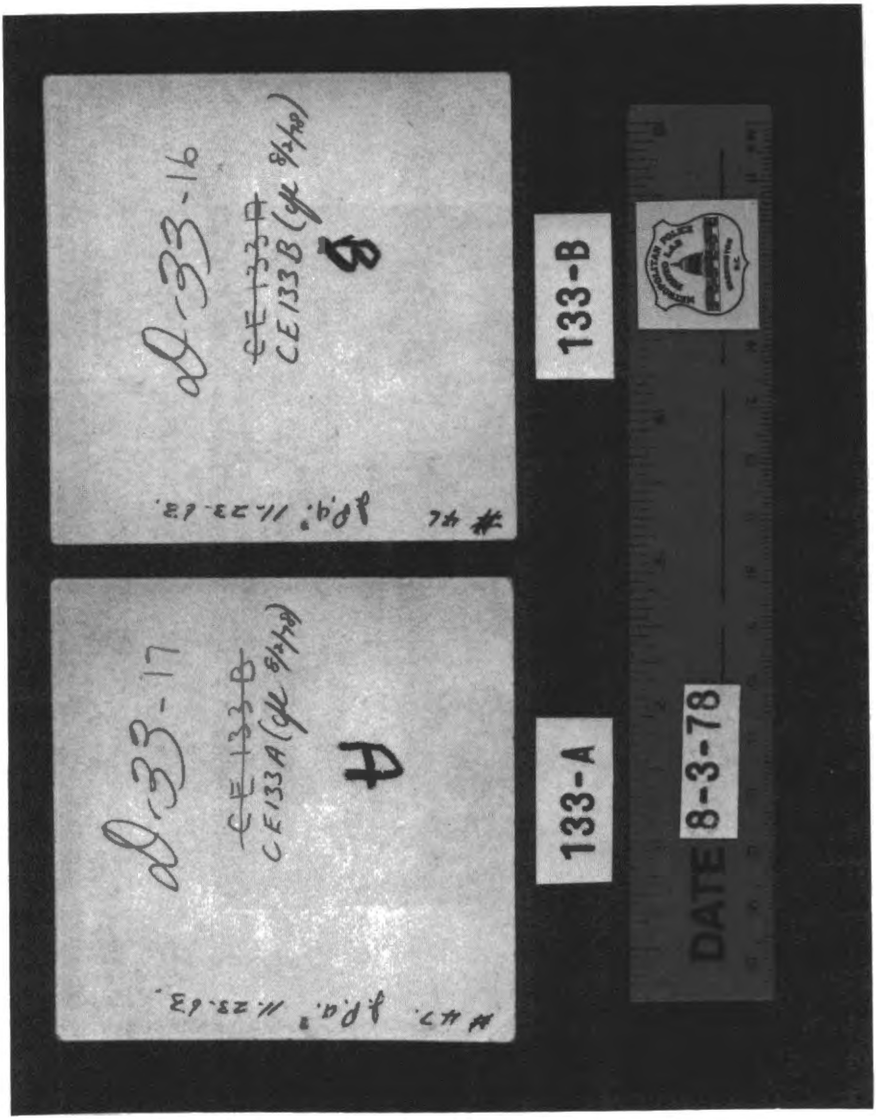


Figure IV-19.—CE 133-A and 133-B (back).

FIGURE IV-20.—133-A (de Mohrenschildt) (front).

FIGURE IV-21.—133-A (de Mohrenschildt) (reverse).

(383) The 133A–Stovall print is approximately 5 by 8 inches. (See fig. IV–22, JFK exhibit F–185.) This is not a standard size for photographic paper. The person who made the print probably took a standard size sheet of 8- by 10-inch paper and cut it in half. Across the bottom border of the print is a black line. The lower right area of the white border above the black line bears a black circle. The black border at the bottom was caused by light spilling over the bottom border of the easel mark because the mask was not wide enough to cover it. Furthermore, since the mask contained a small rivet with a hole through it, the paper extending under this rivet hole allowed the

light from the enlarger to print the image through the rivet hole. These markings are actually sharper than the photographic image. The Panel established that this print was also a first generation print, again because of well-defined markings and emulsion tears.

FIGURE IV-22.

(384) Since the original negative to CE 133-A was square shaped (see fig. IV-20, JFK exhibit F-382), and because 133A-Stovall is rectangular (see fig. IV-22, JFK exhibit No. F-185), it is apparent that the Stovall picture has been cropped with a standard white border for aesthetic reasons.

(385) The 133C–Stovall and 133C–Dees prints (see fig. IV–15) also appear to have been cropped for aesthetic reasons in a manner similar to 133A–Stovall. Moreover, because these two prints had the same well-defined emulsion tears and scratches on them as the other first generation prints, they are likewise considered to be first generation. Both are enlargements from the original negative.*

FIGURE IV–23.—CE–134 (front).

*Dallas police officer R. L. Studebaker testified to the House Select Committee on Assassinations that in 1963, while working in the Dallas Police Department Photography Laboratory, he made numerous copies of the Kennedy photographic evidence for fellow Dallas police officers; included in the pictures distributed were prints of CE 133–A and CE 133–B as well as of the third pose not seen by the Warren Commission. Testimony of R. L. Studebaker, supra note 127.

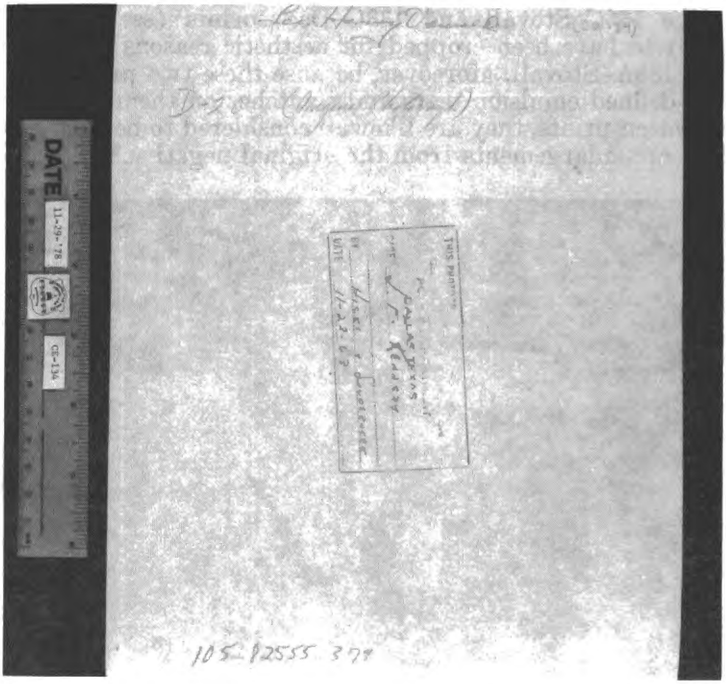


FIGURE IV-24.—CE-134 (back).

FIGURE IV-25.—CE-750. Imperial Reflex camera.

(386) Finally, CE 134 is an 8- by 10-inch enlargement of the CE 133–A negative. (See fig. IV–23.) It apparently was reproduced by the Dallas Police Department by enlargement from the original negative with an easel set that accommodated 8- by 10-inch enlarging paper. The back of the photograph contains an impression from a rubber stamp identifying the Dallas Police Department. (See fig. IV–24.) The emulsion scratches and tears are again evidence that this is a first generation print.

(*2*) *The Imperial Reflex Camera*

(387) Marina Oswald testified to the Warren Commission that CE 750, an Imperial Reflex camera (see fig. IV–25) was used to take the backyard pictures. (*163*) In order both to test the credibility of her testimony and to establish the conditions under which fakery might have occurred, the panel conducted a series of tests to determine whether this camera had, in fact, been used to take the backyard pictures. (*164*) The tests sought to establish whether any of the unique identifying marks of the camera could be found on the backyard picture materials.

(388) Most cameras, particularly inexpensive ones which have been manufactured by injection molding of plastic, have certain imperfections in them such as bumps, notches, nicks, scratches, edge irregularities, et cetera. These imperfections frequently are located on the film plane aperture against which the film lies when it is exposed. As a result of the contact between the film plane aperture and the film, some of these imperfections may be recorded on the border of the film's image area. These imperfections are known as frame edge markings. They are not of concern to camera manufacturers because most customers who use such cameras will have photofinisher prints made which have white borders that crop off the frame edge marking irregularities.

(389) Such markings, however, will remain on the negative and any uncropped prints. Because these markings on inexpensive cameras tend to be distributed in a random pattern unique to each camera, they serve as identifiers for determining whether a particular negative or uncropped photograph was originally exposed in any particular camera.

(390) Another type of camera signature may occur in inexpensive cameras when the film is dragged across the edge of the plastic as it is moved from the supply chamber to the film plane aperture and then to the take-up chamber. This process often causes fine scratches on the emulsion side of the film that may then appear on the actual photographic image. These scratches may coincide with the particular pattern of the plastic molding of the camera. They can serve as unique marks for camera identification.

(391) In order to determine the pattern of these camera signatures in the case of CE 750, Oswald's Imperial Reflex camera, test photographs were made with it and then intentionally underexposed in development to show the frame edge markings better. (No special development method was necessary to bring out the camera scratch mark pattern.) (See fig. IV–26, JFK exhibit No. F–190). Each time the film was run through the camera, the camera signature created by the frame edge markings and scratch marks was found to be the same. (*165*)

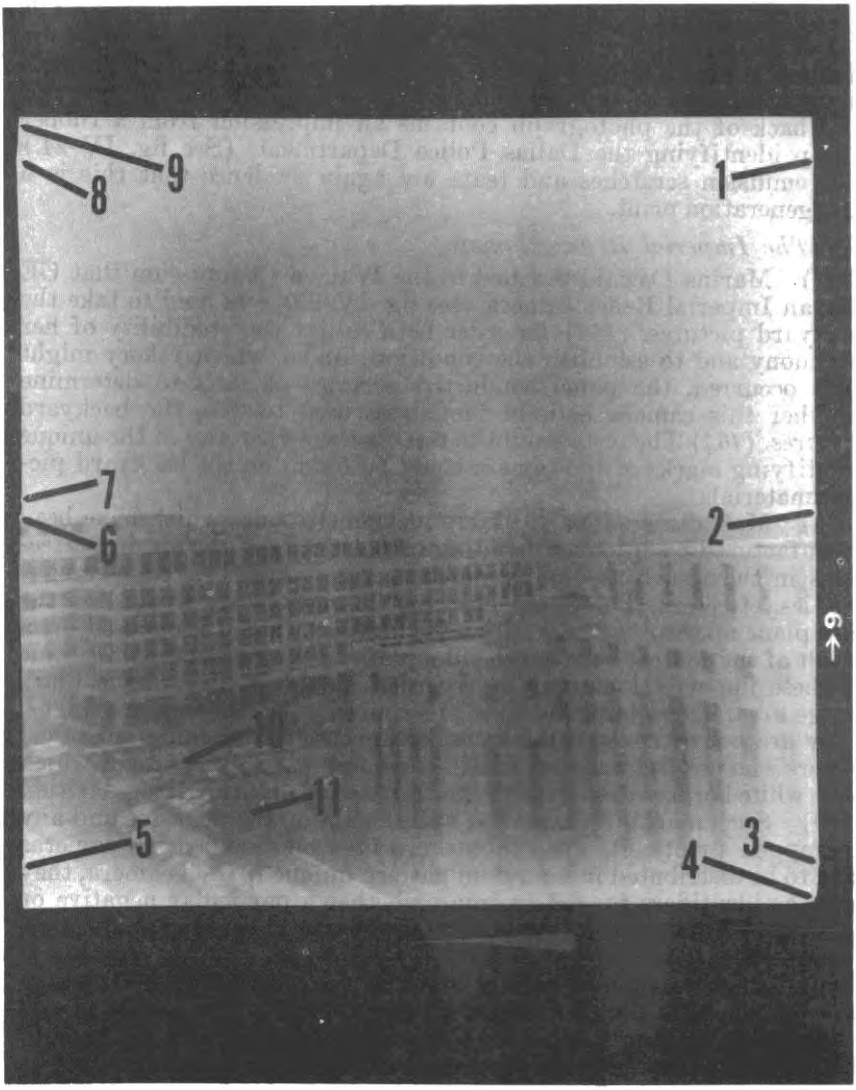


FIGURE IV-26.—Test photograph exposed in Oswald Imperial Reflex camera (CE-750).

FIGURE IV-29.—Frame edge markings and camera scratch marks on the de Mohrenschildt print of CE-133-A.

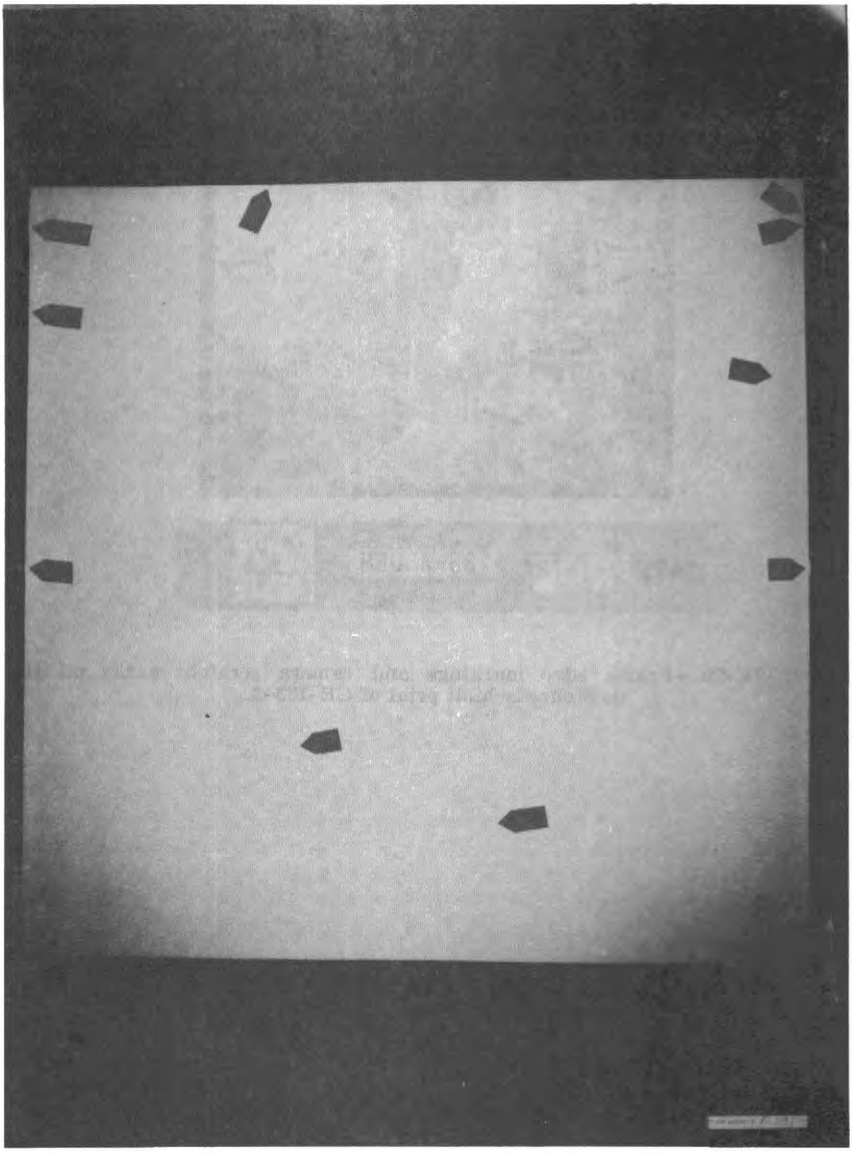


FIGURE IV-27.—Test photograph exposed in another Imperial Reflex camera.

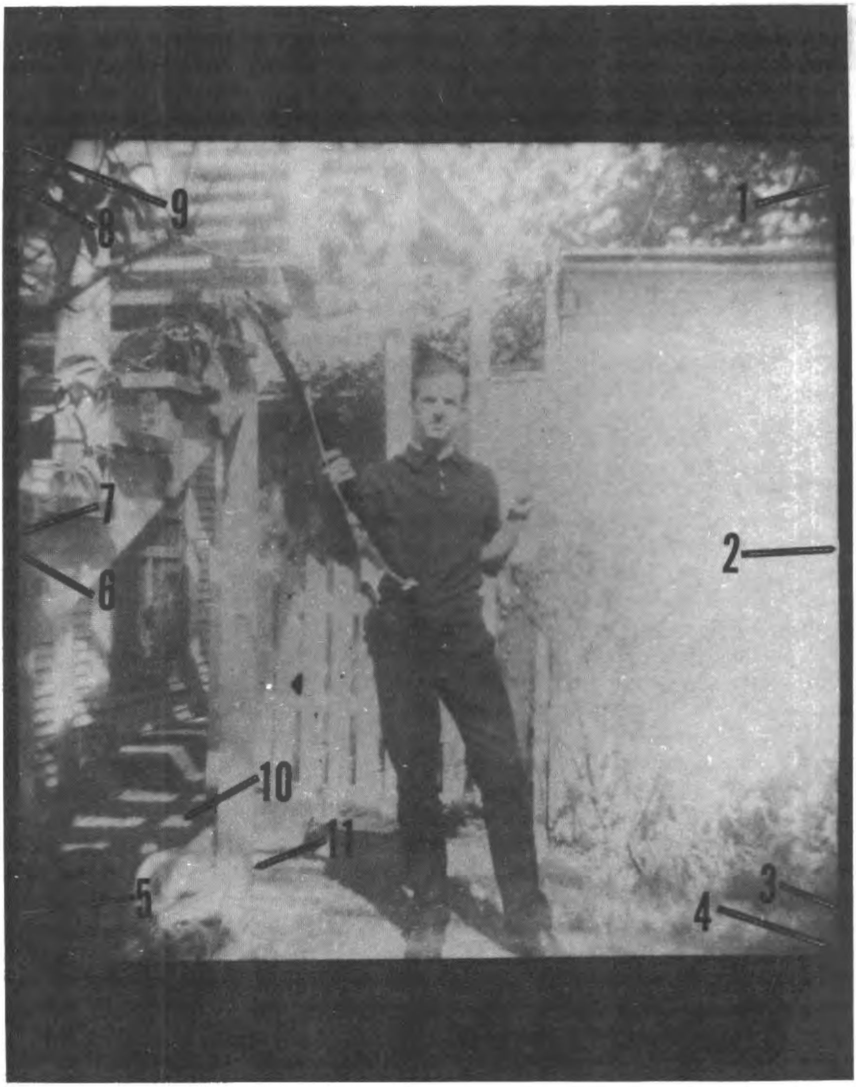


FIGURE IV–28.—Frame edge markings and camera scratch marks on negative of CE–133–B (CE–749).

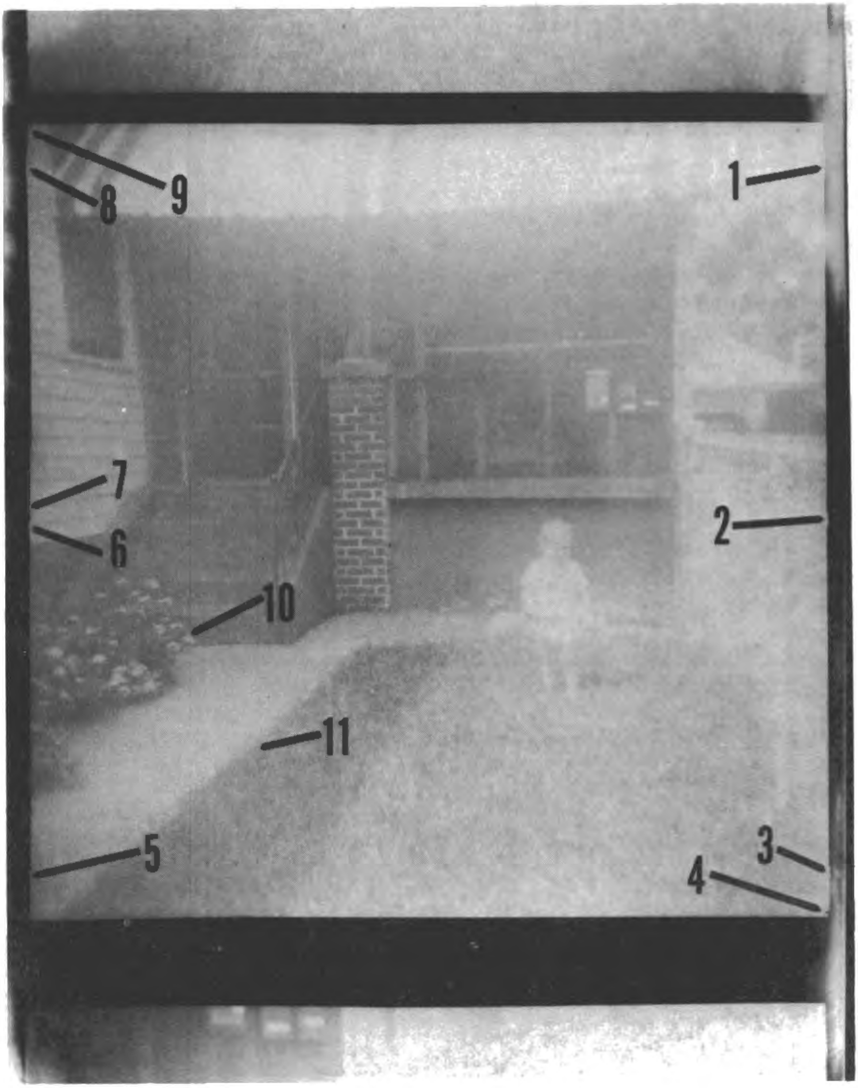


FIGURE IV-30.—Oswald family photograph with same frame edge markings and camera scratch marks as others exposed in CE-750.

(392) The next step was to verify that this frame edge mark pattern and the scratch marks were unique to CE 750. This was done by comparing the test pictures with photographs that had been exposed in two duplicate Imperial Reflex cameras obtained from the Eastman Kodak House in Rochester, N.Y. In each case, the camera signatures were markedly different. (*166*) The comparison thus confirmed that CE-750 had unique frame edge markings and scratch marks. (See fig. IV-27, JFK exhibit F-191.) (*167*)

(393) Because only the 133–B negative (CE–749) and the uncropped 133–A de Mohrenschildt print contained a full image area showing the frame edge markings, only these were compared for frame edge markings with the test photograph. In the case of the 133–B negative, 11 unique identifying frame edge marks were found which corresponded with the test photography. (See fig. IV–28, JFK exhibit F–188.) These identifiers were also present in the 133–A de Mohrenschildt print, although the panel notes that in this case, a light box and magnifier were necessary to detect all of the marks. (See fig. IV–29, JFK exhibit F–397.) *(168)*
(394) These results were confirmed by the panel's scratch-mark analysis. Here, all the backyard picture materials could be reviewed because the scratch marks that were the subject of the analysis had not been cropped out by any of the prints' white borders. The analysis clearly indicated that the scratch marks were located in precisely the same location in each photograph. (See figs. IV–26, 28, and 29.) *(169)*
(395) This analysis established that the Oswald backyard pictures had been exposed in Oswald's Imperial Reflex camera.*

3. ALLEGATIONS OF FAKERY

(a) *Unnatural lines in the vicinity of Oswald's chin*

(396) It has been alleged that there is a line that runs directly across Oswald's chin and is evidence of compositing. No unnatural line indicative of fakery could be discerned by the panel on either the original negative or first-generation prints when these materials were visually inspected using magnifying and microscopic equipment, varying density exposures, and digital image processing. *(171)*

---

*In regard to the allegation that this camera had been used only to take the incriminating backyard pictures of Lee Harvey Oswald, the panel examined all of the photographic material in the National Archives that was listed as having been taken from the effects of Lee and Marina Oswald during the execution of post-assassination searches by the Dallas Police Department. Most of these were family-type snapshots, including scenes of an older child and baby in a crib, Marina Oswald playing with a child, and Lee Oswald holding an infant. The frame edge markings appearing on the negatives to these photographs and the camera scratch marks appearing directly on the pictures were studied and found to be entirely consistent with both the original test materials and the Oswald backyard pictures which were exposed in the Oswald Imperial Reflex camera. For example, figure IV–30 (JFK exhibit F–189) is a photograph which has been identified by Marina Oswald Porter as depicting one of the two children that she had by Lee Harvey Oswald. *(170)* The negative of figure IV–30 was found to contain the same camera identifiers and scratches as the other first generation prints and original negative made in the Oswald camera. It is, therefore, apparent that this photograph was also taken by Oswald's Imperial Reflex camera.

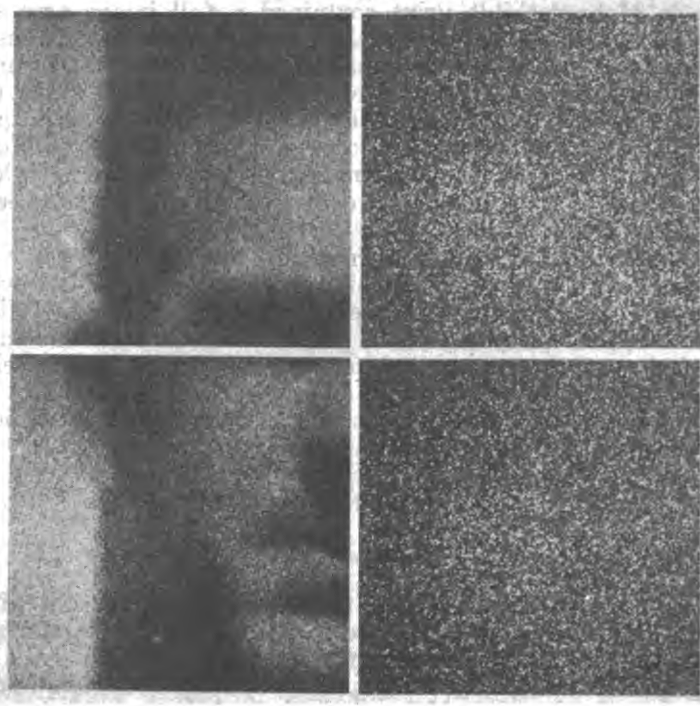


FIGURE IV–31.—Grain structure analysis of CE 133–B utilizing digital image processing.

(397) As noted earlier, photographic images such as the backyard pictures are composed of very small, irregular shaped grains of silver suspended in a gelatin layer. On a given photograph, a uniformly exposed area has a generally uniform distribution of such grains. In contrast, on composited photographs, the grain distribution may be noticeably different. When the panel microscopically examined the area above and below the horizontal chin cleft in the backyard pictures, no difference in grain structure could be found. (*172*) (See fig. B–16, JFK exhibit F–197.)

(398) The 133–B negative (CE 749) was digitally processed at the Aerospace Corp. and the University of California Image Processing Institute using several different image-processing techniques. This process confirmed that the grain distribution was uniform. (*173*) (See fig. IV–31, JFK exhibit 197.) Under very carefully adjusted display conditions, the scanned image of the Oswald backyard negative did exhibit irregular, very fine lines in the chin area. The lines appeared, however, only with the Aerospace gradient-enhancement process, where the technique was applied at a much higher resolution (i.e., the image area scanned was magnified since only a small portion of the picture was being subjected to the computations).

(399) Although the cause of these lines has not been definitely established, there is no evidence to indicate that they are the result of an attempt to fake the photograph. This is because similar, although less pronounced, lines were found using the same digital enhancement technique on a known authentic photographic negative. Therefore, those lines may have been a product of the enhancement process.

(400) Supporting evidence for this conclusion is that the fine lines were not observed in photo-optical photochemical enhancements or in phase-contrast microscopic inspection of the chin area. In addition, the lines are disconnected; they do not cross the entire chin and are extremely fine, roughly equal in width to the size of the grain clumps in the emulsion.

(401) Three other possible causes for the lines are suggested:

(402) *(1)* They could be due to the presence of very fine scratches on the glass plate used to support the film while it was being scanned;

(403) *(2)* They could have been introduced during the film drying process. Particulate and dissolved material in the film wash water can leave a so-called water stain on film. As the water evaporates, the particulate and dissolved material is deposited on the emulsion, usually in thin, irregularly shaped lines. The probability of the lines being caused by very faint water stains is heightened by the observation of very noticeable stains in the neck and ear area, as discussed below.* These marks are found in the work of photographers who pay inadequate attention to the washing and drying steps in the processing of film;

(404) *(3)* Changes in emulsion temperature during processing can cause silver grains in the emulsion to clump together in fine linear patterns, an effect known as reticulation.

(405) While subsequent generation prints of the backyard pictures appear to show a line running across Oswald's chin, *(174)* this phenomenon is not surprising because copy prints often have higher contrasts than originals. If an object or an original photograph of the object has a rather diffuse band that is dark at the center but becomes progressively lighter at the edges, a photographic or printed ink copy very often will show that band as a distinct line with sharp edges. In generating a copy photograph, the photographic or printing process may not be able to depict the entire tone range of the original object or photograph. In that case, a range of lighter tones will all appear as a single light tone and a range of darker tones will all appear as one dark tone. It is in this way that a broad smooth tone scale becomes a sharp transition from dark to light. This apparently happened in copies of the Oswald photographs, causing the shadow across the chin to appear to be a sharp line. Accordingly, no probative value can be attributed to such materials.

---

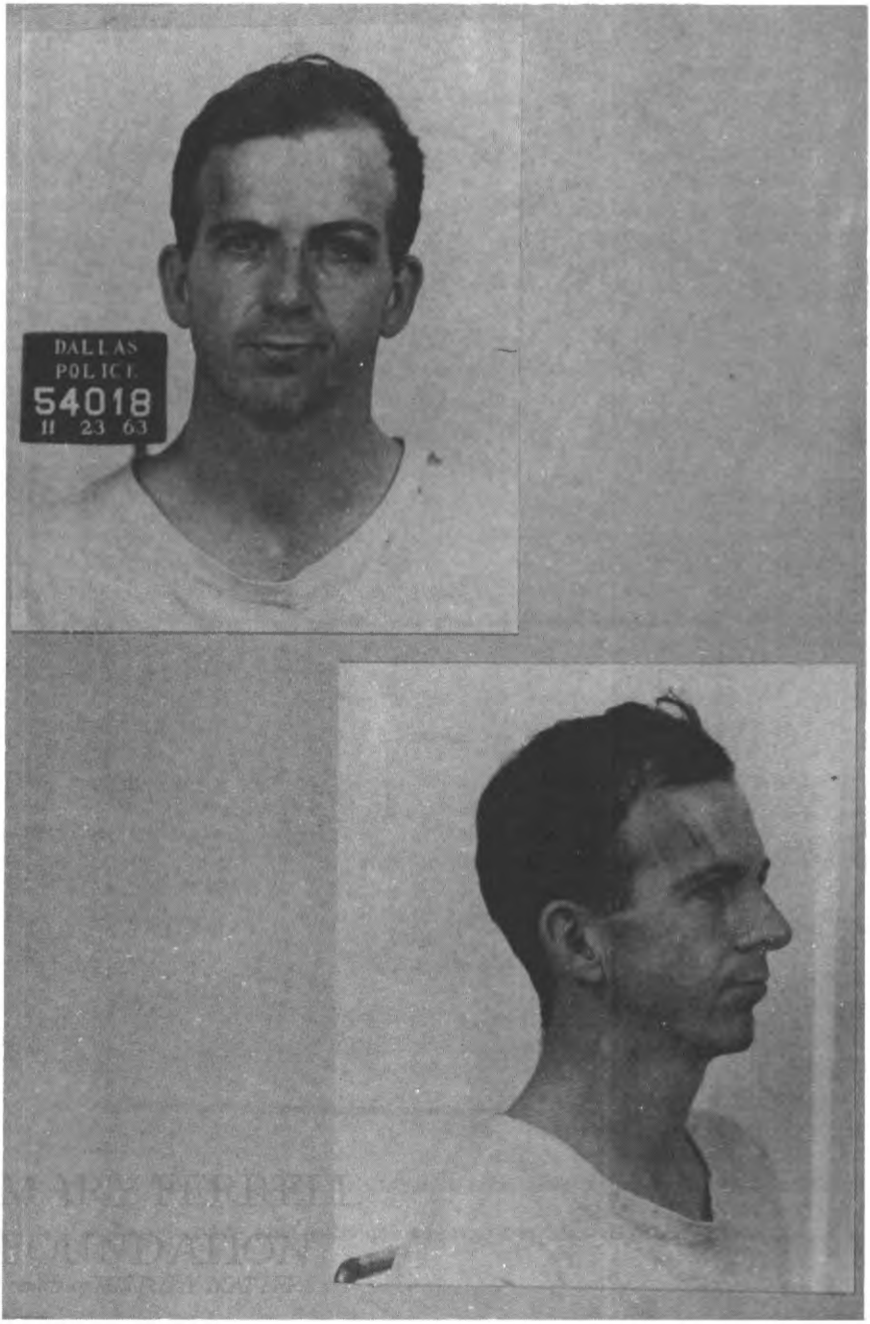
*See pars. 406–407 infra.

FIGURE IV-32.—Water spot analysis of 133-A Stovall.

(406) The Panel did note a very fine line on an enlargement of CE 133-A. It ran from the edge of Oswald's left ear into the chin area and continued downward and around to form an irregularly shaped, closed ring. If this were a photographic image of a line where parts of a picture had been pasted together, the image of the line would be composed of photographic silver grains. Here, however, the line was actually finer than the silver grains and was continuous rather than beaded and broken as it would have been had it been composed of silver grains. Experienced photographic technicians recognize this type of line as the edge of a water spot. (See fig. IV-32, JFK exhibit F-196.)

(407) When the negative was developed, fixed, and washed, a spot of water was left on the film surface. As it dried, it left a mineral residue and/or microscopic distortion of the gelatin surface surrounding the area where the drop had been located. Because very similar configurations were seen on more than one of the 133-A prints, the defect must have been on the original negative. Images of similar water spots were found on the image of the shirt at the left shoulder and on the image of the stock of the rifle. Similar water spots were observed as well as on the negative of CE 133-B (CE 749) on prints made from that negative, and on 133-C.

(408) Moreover, on comparing the backyard prints with known photographs of Oswald, the Panel observed that he quite clearly had a natural line running across his chin. (See fig. IV–33, JFK exhibit No. F–194.) It appears in the photographs as an indentation.



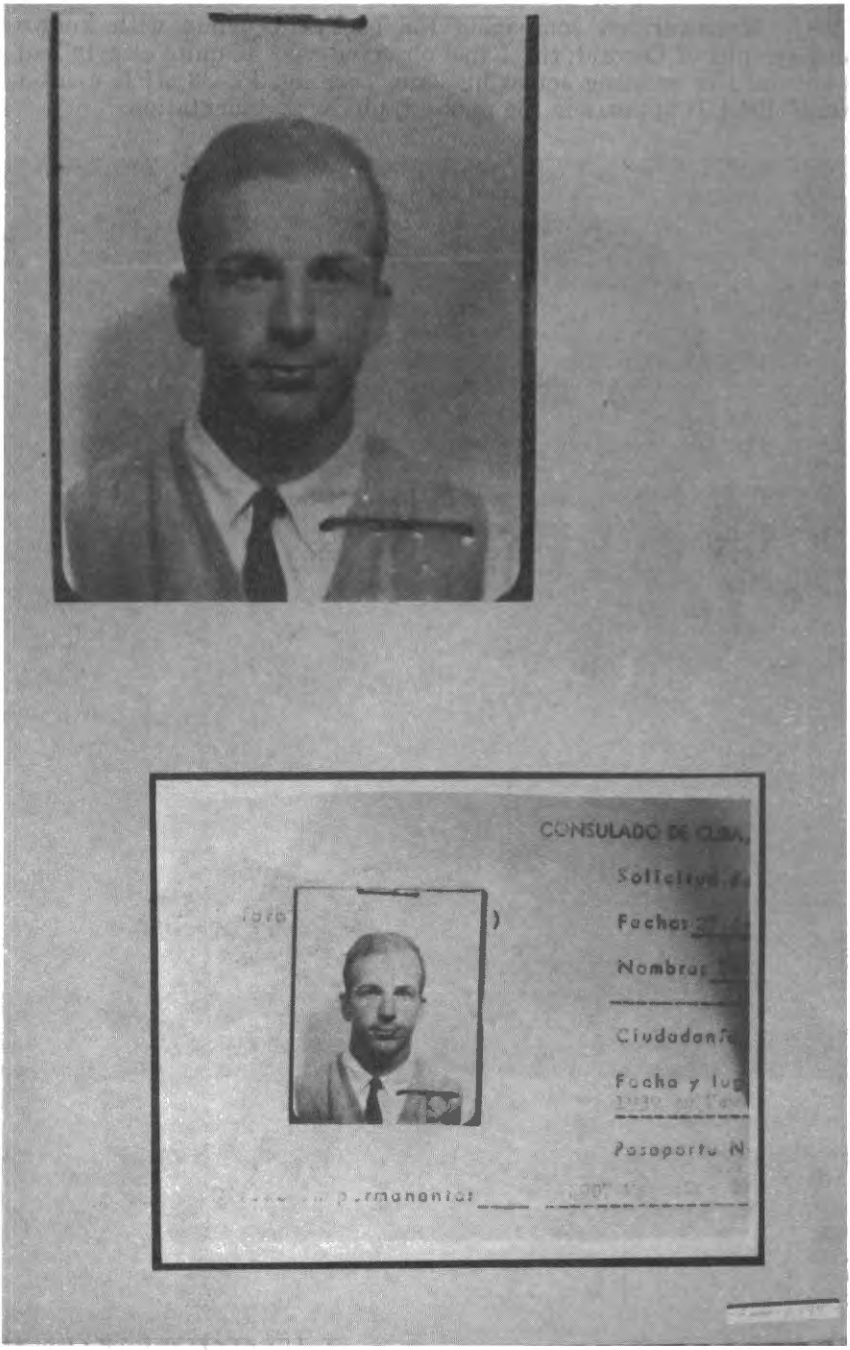


FIGURE IV–33.—Oswald photographs depicting chin characteristics.

(409) The chin area of the backyard pictures has also generated controversy because of the allegation that the chin appears rather flat across the bottom, whereas in other photographs it is more pointed, or at least rounded, with a vertical cleft at the bottom. It has been asserted that the chin in the backyard prints actually belongs to another man.

(410) A profile photograph taken by the Dallas Police Department, shows that the lower half of Oswald's chin had a roughly cylindrical protrusion with a horizontal axis. (See fig. IV–33, JFK exhibit No. F–194.) When the chin was lighted by direct sunlight coming from nearly overhead, the protrusion cast a shadow over the bottom part of the chin. The upper edge of the shadow was a nearly straight horizontal line. The bottom of his chin, like his eyes and neck, is in such deep shadow that it is not visable. Thus, the shape of Oswald's chin and the type and direction of illumination are responsible for the relatively flat appearance of his chin.

(b) *Unnatural and inconsistent shadows*

(411) An argument has been advanced that some of the shadows cast by Oswald and other objects in the backyard prints contain no detail and consequently must have been painted on a montage.(*175*) In addition, the directional consistency of the shadows both in terms of the objects casting them and with respect to each other has been challenged.(*176*)

(412) The first of these claims was found to be false simply by studying the prints of CE 133–A and CE 133–B that had been made at varying exposures to facilitate examination for detail. The prints of normal and greater than normal lightness revealed great detail in the shadow areas. (See figs. IV–16, IV–17, JFK exhibit Nos. F–192–193.) Grass, a small branch, what appear to be stones, clods or parts of leaves, and a newspaper can be seen. Blades of grass are silhouetted against the edge of the newspaper.

(413) This aspect of the photographs appears normal. The shadows are illuminated by light reflected from the white or light-colored picket fence and wall in the background. For this reason, the shadows on the ground are not as dark as the shadows over the eyes and throat that did not receive such illumination. The detail within the shadows and the variations in density between them preclude the possibility that they were painted onto a montage.(*177*)

(414) The consistency of the shadows was also evaluated by application of the vanishing point principle. The concept of "vanishing point" perspective is widely known with respect to artists and applies to photography as well. (*178*) This concept simply means that parallel lines in object space are depicted as converging lines on the image which will eventually meet at a point. Because the Sun's distance from Earth is so great that it may be considered infinitely distant, it follows that, in any sunlit scene, lines from objects to their shadows are parallel. When these parallel lines are pictured, the corresponding lines on the picture converge at a point known as the vanishing point. A picture of parallel railroad tracks provides a good illustration; the tracks are seen to converge to a point at the horizon.

(415) In the case of the railroad tracks, the vanishing point is in the picture. This may not always occur. If the lines are perpendicular to the camera axis (the line from the center of the lens to the center of the film), the images of the lines will not appear to converge at a point on the picture. The vanishing point may then be considered to be at infinity. In other cases, where the parallel lines are not perpendicular to the camera axis, the vanishing point is either in the picture or some finite distance outside it.

(416) When this is the case, the directional consistency of shadows may be tested by drawing lines from images of objects to the corresponding points on the images of their shadows, and then extending these lines (beyond the actual picture if necessary) to see if they all meet at one point. If the lines do meet at one point, they are parallel and therefore consistent. If they do not meet at one point, they are not parallel and consequently are not consistent.

(417) When this analysis was applied to the backyard prints by drawing lines from a part of the stairway, the butt of Oswald's pistol, the muzzle of the rifle, Oswald's nose, et cetera, to the corresponding points on the shadows cast by these objects, the lines all met at the vanishing point. (See figs. IV–34 and IV–35, JFK exhibits Nos. F–387 and F–388.) Accordingly, the shadows were determined to be directionally consistent. A vanishing point analysis on 133C(Stovall) also yielded consistent results.

(418) While the vanishing point analysis settles this issue, comparisons between shadows depicted in different backyard pictures cannot be validly made unless the illumination, precise geometry of the head and the exact location of the camera are considered. It is for this reason that the allegation of fakery, based on the observation that a shadow has not moved between pictures despite movement of the object casting it, is fundamentally misconceived. The argument fails to account for the compensating effect of movement by the camera. (*179*) This principle is illustrated in the RIT Technical Report, pars. 470–74 infra.

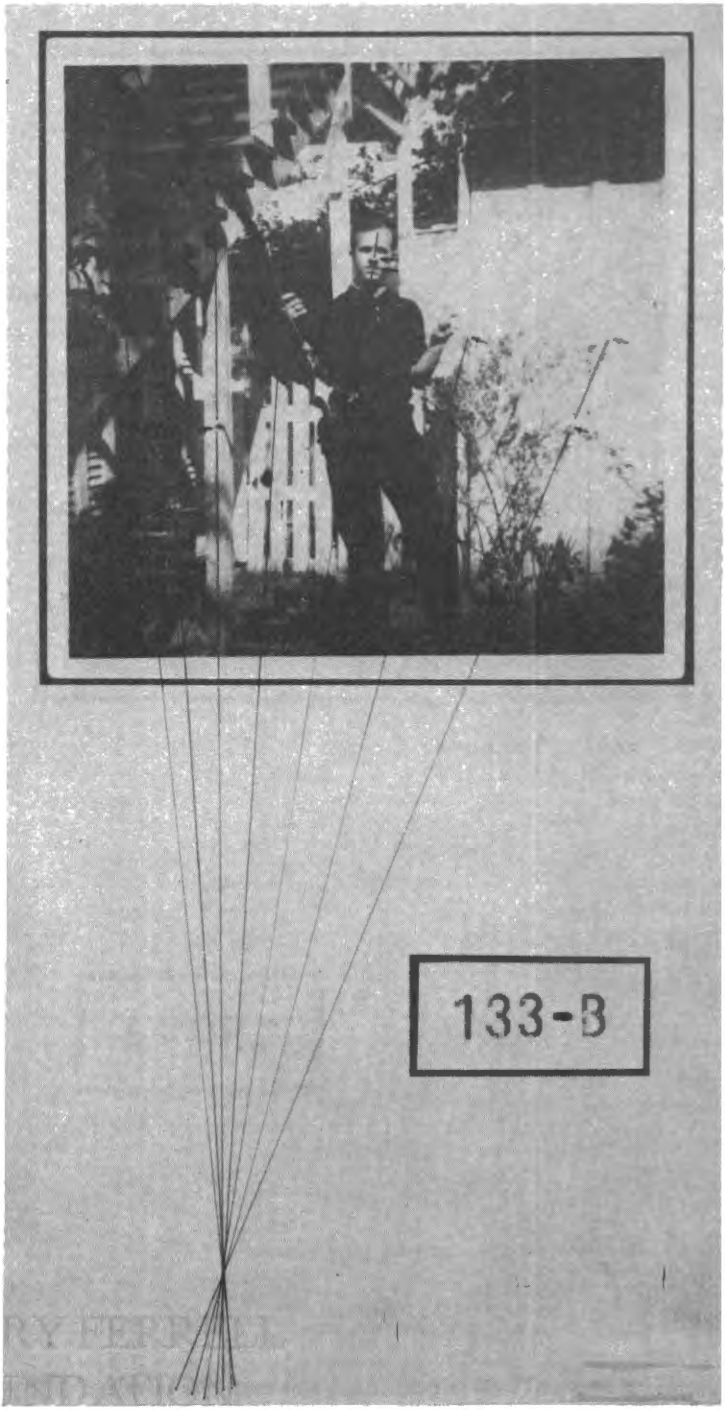


FIGURE IV-34.—Vanishing point shadow analysis.

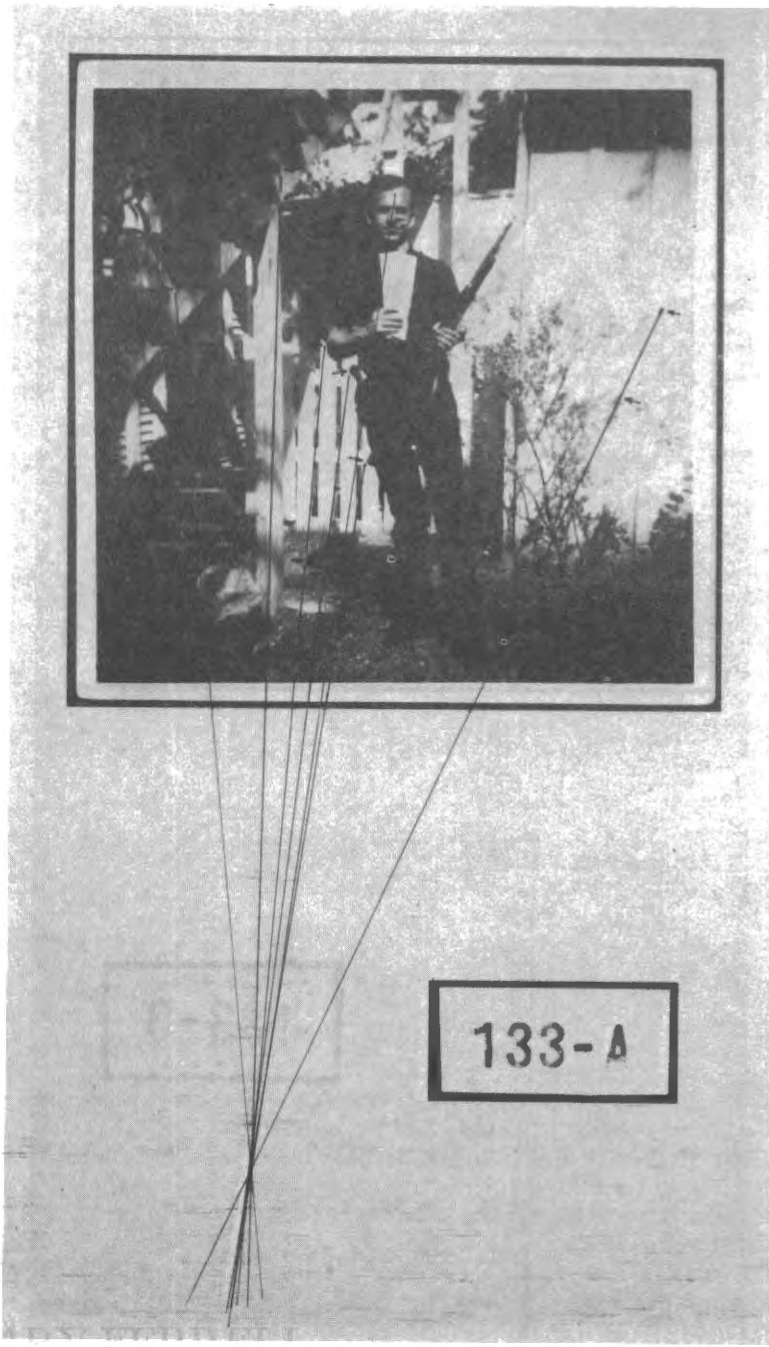


FIGURE IV-35.—Vanishing point shadow analysis.

FIGURE IV-36.—Third backyard picture pose "133-C."

(419) Finally, the shadows in these pictures were also analyzed to determine the sequence in which the photographs were taken. A visit to the Neeley Street site of the backyard photographs established that a person walking up the steps would be walking almost straight east. (*180*) Given the view shown in the backyard photographs, it is possible to estimate that the camera was aimed about 70° east of north. The shadows in the photographs indicate that the Sun was

behind and to the right of the camera. Since this would place the Sun in the southwestern sky, it was afternoon, and the Sun was going down.

(420) In the photographs, three horizontal linear shadows may be seen crossing the post in the foreground of the pictures and continuing along the ground behind the subject. These may have been shadows of power cables or some similar object. There is a knot in the post between the lower two shadows that may be used as a visual reference point. The shadows are lowest relative to the knot on 133–C, highest on CE 133–A, and in an intermediate position on CE 133–B. The Sun position would cause the shadows in the backyard pictures to move upward on the post with the passage of time. Therefore, since the shadows were moving upward, 133–C was taken first, followed by CE 133–B, and then CE 133–A. (See figs. IV–18, IV–20, and IV–36.) (The possibility of additional intervening photographs cannot be discounted.)

(421) The photographic technique improved appreciably during the sequence. For 133–C, the camera was not held level and the subject was not centered. The camera was rotated slightly as the shutter release was pressed. This caused the detail to be fairly sharp in the vicinity of the bush shown at the right, corresponding to the axis of rotation, while there is rotational blur elsewhere, such as in the area of the steps. In CE 133–B, the camera was held level and steady, but the subject's feet were not in the field of view. For CE 133–A, the camera was held reasonably level and steady, and the subject was well centered.

(c) *Evidence of retouching*

(422) Each of the backyard pictures, as well as the only original negative, was examined microscopically for evidence of retouching. No such evidence could be detected. Particular attention was given to the area to Oswald's left in CE 133–B, where it has been alleged that a retoucher painted on a montage but carelessly allowed the color material to spread onto the front of a nearby vertical post, thereby giving the appearance of an indentation on the post that does not appear in either of the other two backyard pictures. (*181*)

(423) Close examination of the original print revealed that the apparent indentation is a shadow, most likely of a leaf or leaves. The straight edge of the post is still visible in this shaded area. This straight edge was detected and indicated by a computer programed to seek such edges. (See fig. IV–37, JFK exhibit F–198.) (*182*)

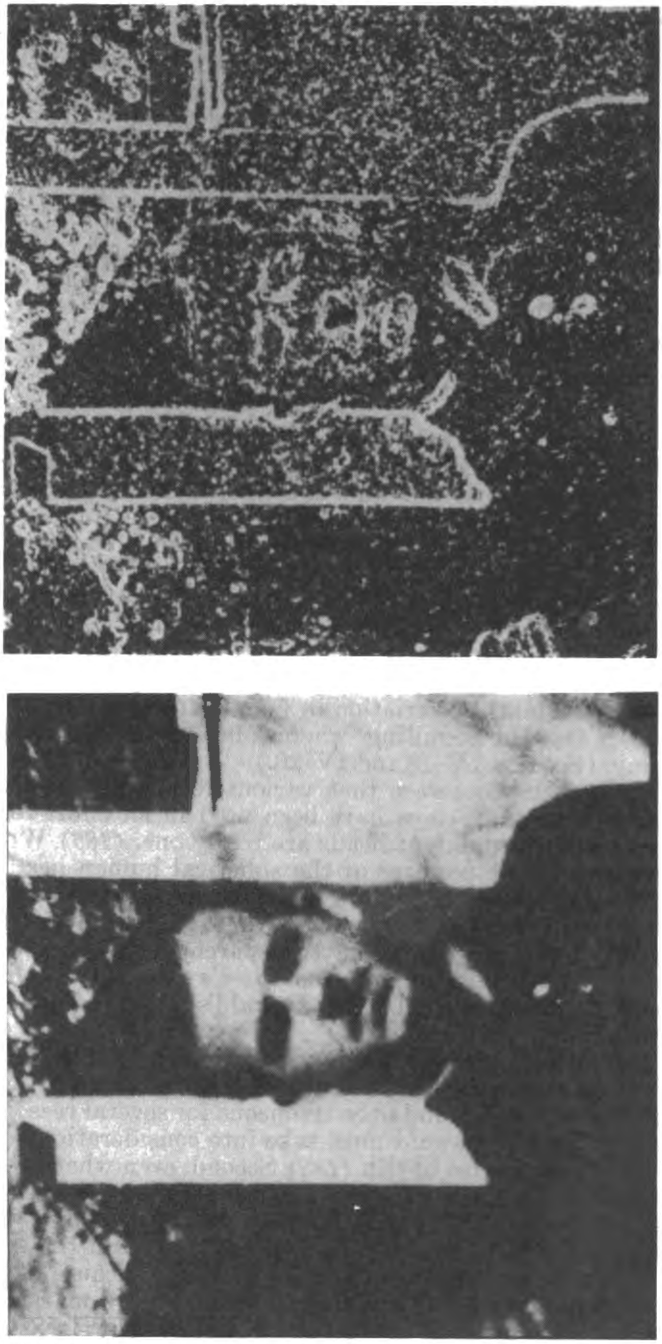


FIGURE IV-37.—Edge analysis of CE 133-B utilizing digital image processing.

(424) The other two pictures, CE 133–A and 133–C, show that the post casts a shadow on the white surface behind it. The shadow is wide enough to fill the image area between Oswald's neck and post. Consequently, since the darker area to the left of the post is the shadow of the post on a white surface, a shadow falling on the white post itself would be similar in tone to the background and could be mistaken as part of the background rather than as a shadow on the post.
(425) Finally, careful inspection detects a crooked linear image of what appears to be a thin branch or a wire clothesline in this picture. The image of this line runs continuously through the area in question between Oswald's neck and the post. It is unlikely that a retoucher who would faithfully preserve detail as fine as this wire would fail to follow the straight edge on the post. (*183*)

(d) Oswald's identical heads and inconsistent body proportions

(426) Allegations have been made that Oswald's head appears to be absolutely identical in each of the backyard pictures examined by the Warren Commission and that this is evidence of a single head being used for the compositing of CE 133–A and B. (*184*) Further support for this argument has been advanced by Warren Commission critics who have maintained that in each of the pictures Oswald's head is the same size, even though the length of his body varies considerably. (*185*)
(427) There is no support for the statement that Oswald's head is identical in each of the backyard pictures. If anything, the photographs showed a marked variation in facial expression. For example, in CE 133–A Oswald is smiling, whereas in CE 133–B he appears to be frowning. (See figs. IV–18 and IV–20.)
(428) The panel was aware that various techniques involving the use of transparency overlays have been used in an effort to demonstrate that the three different heads are really one. (*186*) When soft-edged images such as pictures of the spherical human head are the subject of analysis, the absence of a sharp demarcation for comparison precludes such methods from serving as an accurate basis for making comparisons. Even so, when the transparency overlay method of analysis was undertaken by the committee's contractors, the differences in the shape and size of Oswald's head became readily apparent. (*187*)
(429) The argument that there is evidence of fakery because Oswald's head size is the same in each of these pictures, although his body size changes, was found to be erroneous for several reasons. First, any measurements of Oswald must take into consideration variations attributable to his degree of tilt. (*188*) Second, even when the tilt factor is ignored, Oswald's head length measures differently in each of the photographs.* Finally, there is nothing unusual about a series of photographs in which head length appears to remain the same even though the subject's body length seems to vary. Because of its rigid structure, the head when photographed (even with a marked change of expression) is subject to considerably less variation in length than

---

*For Oswald head length measurements taken from CE 133–A and B, see table I, "Comparison of Oswald Photographs," par. 732, infra.

the rest of the body, which tends to be affected more by variations in posture. (See fig. IV–38.)

(430) When the panel reviewed previous studies analyzing the relative proportions of Oswald's body length to the length of the rifle depicted in the pictures, (*189*) it became apparent that these analyses had also failed to consider variations in posture and effect of tilt on the apparent length of a photographed image. Moreover, variations in Oswald's posture as depicted in these pictures make such an analysis meaningless.

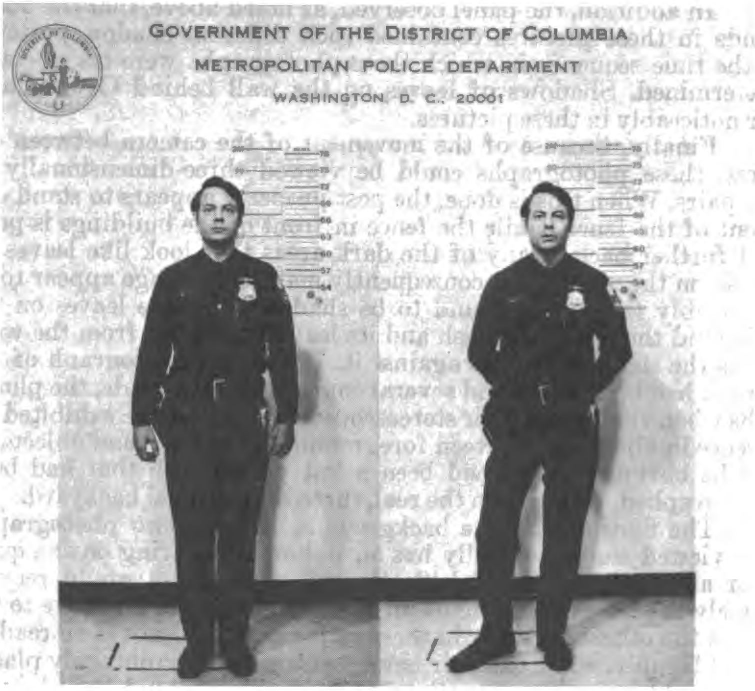


FIGURE IV–38.—Effect of postural and facial expression variations on statural and facial measurements taken from photographs.

(e) The identical backgrounds

(431) The allegation has been made that the backgrounds in these pictures are identical and that three differently posed subjects had been superimposed on copies of one background picture. (*190*) The proponent of this theory, however, had never measured the distance between any relevant reference points in these pictures to determine whether there had been camera movement between the taking of each photograph. (*191*) Had this been attempted, the analysis would have revealed both horizontal and vertical movement between pictures.

(432) The panel determined that there had been horizontal camera movement. It measured the difference in alinement between pictures of particular foreground and background objects. For example, the prominent post in the foreground of each picture has a picket fence on both sides of it. The term "a" was designated as the distance from

the left edge of the image of the post to the left edge of the left-hand picket at the end of the fence, "b" as the distance from the right edge of the image of the post to the right edge of the image of the right-hand picket. If the camera had moved between exposures, the ratio of "b" to "a" should differ between viewpoints in different pictures.

(433) This ratio was measured at three different heights on corresponding places on CE 133–A and B, and in all three instances a measurable difference was found. A similar technique was used with similar results to determine that there had also been vertical camera movement between pictures.*

(434) In addition, the panel observed, as noted above, that the backgrounds in these pictures contained such different shadow patterns that the time sequence in which these photographs were taken could be determined. Shadows of leaves on the wall behind Oswald also differ noticeably in these pictures.

(435) Finally, because of the movement of the camera between exposures, these photographs could be viewed three-dimensionally in stereo pairs. When this is done, the post properly appears to stand out in front of the fence, while the fence in front of the buildings is positioned further back. Many of the dark areas that look like leaves on the bush on the right (and consequently make the foliage appear to be unseasonably thick) are found to be shadows of these leaves on the wall behind the bush; the bush and its leaves stand out from the wall, whereas the shadows lie flat against it. If a single photograph of the backyard had been taken and several copies of it then made, the photographs when viewed together stereoscopically would have exhibited no difference in alinement between foreground and background objects. It would be obvious that it had been a flat photograph that had been rephotographed, rather than the real, three-dimensional backyard.

(436) The finding that the backgrounds of these two photographs can be viewed stereoscopically has an important bearing on the question of authenticity. The falsification of stereo pairs would require extremely precise positioning of all points in one image relative to the points in the other. An error in the relative positions would be readily detected because, when the pair is viewed together, erroneously placed points would appear to lie either in front of or behind the plane in which they should be lying. It is unlikely that a sophisticated conspirator would attempt to falsify images by producing a stereo pair, since one picture would obviously be sufficient, easier to produce, and less susceptible to detection.

4. PRACTICAL CONSIDERATIONS

(437) Beyond the evidence produced by the use of the various photographic analyses, which did not detect any evidence of fakery in the backyard pictures, several practical considerations reinforce these conclusions. For example, the FBI established that the newspapers that appear in the photographs did not reach Oswald until March 27, or 28, 1963, and the committee determined that by April 5, 1963, Oswald had already autographed the back of one of the pictures (133A–DeM). (*192*) Aside from the obvious

---

*See addendum A, pars. 440–445 infra, for horizontal and vertical parallax measurements.

question of whether Oswald would place his signature on a fake picture, for the photograph to have been faked would have required access, within just a 10-day period, to Oswald's backyard, his camera, rifle (knowing that this would be the assassination weapon), and newspapers.

(438) While such access without Oswald's knowledge would theoretically have been possible, it is regarded as unlikely. Moreover, a fundamental question is whether a sophisticated conspirator would expose himself to unnecessary risks of detection by making three fake photographs, when just one would suffice. Using stereoscopic analysis, any inconsistent evidence of fakery would be detected, as literally floating in the image space of the photograph.

(439) Another important consideration mitigating against fakery is the obvious improvement in quality as the sequence of photographs progressed—133C, CE 133-B, and CE 133-A. Quite clearly a learning process was taking place, as the photographer determined, among other things, how the subject could best be centered in the field of view. Finally, the presence of graphite marks on CE 133-A and CE 133-B strongly suggests that the prints were routinely developed by a drugstore or camera store photofinisher's laboratory. It is unlikely that a sophisticated conspirator would have given the end product of his doctoring efforts to a drugstore for printing. Malcolm Thomson, the British forensic photography expert who publicly questioned the authenticity of the backyard picture, was shown a preliminary summary of the panel's report and asked to comment. He was also offered an opportunity to appear before the committee to express his views. After studying the reports, Thomson deferred to the panel's conclusions that the photographs revealed no evidence of fakery. He noted the thoroughness of the panel's investigation and emphasized that his earlier comments were based upon examination of copies of the photographs rather than the original material. Thomson did, however, reserve his opinion that the chin in the backyard pictures was suspiciously different from the chin that he had observed in the Dallas arrest photographs of Oswald. He also remained skeptical as to the ability of a computer to detect a photocopied composite photograph. *(193)*

The photographic analyst with the Canadian Department of Defense who had stated that there was evidence of fakery in these photographs was also contacted by the committee. He indicated that he had performed no scientific tests on the photographs and had spent less than an hour examining the "very poor copies" that were submitted to him. *(194)*

ADDENDUM A

Measurements of Horizontal and Vertical Parallax*

(440) Both the horizontal and vertical parallax between the two Oswald backyard photographs CE 133-A and 133-B were measured. This was done by measuring the difference in alinement between particular objects in the foreground and background. The post, prominent in the foreground of each picture, has a picket fence behind it

---

* Parallax is "[t]he apparent shift in relative position (or shape) of an object when it is viewed from different positions." L. Stroebel and H. N. Todd, *Dictionary of Contemporary Photography* (1974).

and extending to both sides. The post and fence provided clearly delineated and easily identifiable corresponding points for measurement of horizontal movement (i.e., horizontal parallax) of the camera between exposures. A horizontal part of the fence and the lower edge of the screen of a screen door in the background provided points for measurement of the vertical parallax.

(441) Horizontal parallax was measured at three different heights on the picket fence: the lower level was just above the top edge of the lower horizontal member of the gate; the middle level was in line with the lower edge of the middle horizontal member of the gate; the upper level was in line with the lower edge of the top horizontal member of the gate. (The four pickets and the three horizontal members give the appearance of a gate because they are evenly spaced, but actually they stand at an angle to the vertical member seen alongside the post in the foreground.) At the lower and middle levels, the distance "a" from the left edge of the foreground post to the left edge of the picket to the left of it was measured, and the distance "b" from the right edge of the foreground post to the right edge of the picket to the right of it was measured. At the upper level, because the right edge of the right-hand picket falls into shadow and is not clearly delineated, the distance between the right edge of the foreground post and the right edge of the second picket, which appears to be the first picket of the gate, was measured. The results of the measurements and computations are as follows:

	a equals (mm)	b equals (mm)	b/a equals
Lower level:			
133A	6.8	9.0	1.32
133B	6.0	9.5	1.58 1.32/1.58=0.84
Middle:			
133A	6.5	9.3	1.43
133B	6.4	10.0	1.56 1.43/1.56=0.92
Upper:			
133A	7.0	22.7	3.24
133B	5.9	23.6	4.00 3.24/4.00=0.81

(442) In all cases, more of the background is shown to the right and less to the left on CE 133–B as compared to CE 133–A. Since the shadow analysis indicated that CE 133–B was taken before CE 133–A, the parallax indicates that the camera was moved slightly to the left between these two exposures. The ratios shown at the far right of the table of values differ for two reasons. The sharpness of the edges to which measurements were made was quite poor, so that the difference between the measurements at the lower and middle levels is probably largely experimental error. The measurement of the upper level, as noted, was actually a measurement that used a different reference point and, therefore, would not be expected to result in the same ratio.

(443) Vertical parallax was calculated by measuring the vertical distance from the center of the dark horizontal object, which looks like it might be a gate bolt or latch, to the bottom edge of the screen of the screen door in the background. To establish scale, that is to take into account differences in magnification, these measurements were related to the distance from the left edge of one picket to the left edge of the next, measured in a horizontal direction. This scaling distance was measured on the two center pickets of the four that appear to consti-

tute the gate at the level of the lower edge of the top horizontal member. The results are as follows:

133A: gate bolt to screen=30.4 mm, scaling dist.=15.5 mm
30.4/15.5=1.96
133B: gate bolt to screen=32.1 mm, scaling dist.=15.2 mm
32.1/15.2=2.11

(444) Since less background appeared above the gate bolt on 133A than on 133B, the camera was moved slightly downward between these two exposures. Less certainty can be attached to this determination than to the determination of horizontal parallax for two reasons. Only one, rather than three determinations, was made. Second, in the horizontal case, the determination was made more sensitive to parallax because, as the camera moved, the picket to the right became narrower, while at the same time the picket to the left became wider. Thus, in the ratio b/a, the numerator was diminishing as the denominator grew. This double effect was not present in the determination of vertical parallax. Nevertheless, there is additional evidence of vertical parallax. Between the first and second pickets from the left in the gate, just below the bottom edge of the upper horizontal member, a small black rectangle appears. It appears more elongated in the vertical direction on CE 133-A, as one would expect if the camera were moved down between exposures, exposing more of the dark area in the background.

ADDENDUM B

Report to the House Select Committee on Assassinations U.S. Congress—House of Representatives

THE OSWALD BACKYARD PHOTOGRAPHS

(By Dr. Leslie Stroebel, Mr. Andrew Davidhazy, Dr. Ronald Francis)

The Oswald Backyard Photographs

INTRODUCTION

(445) This report deals with the authenticity of the photographs of Oswald in a backyard, including prints of three different views and a negative of one of these views. Twenty-two specific questions concerning the authenticity of these photographs were presented to the undersigned by the photographic panel. Most of the questions are related to claims made by various persons in the mass media that fakery was involved in the production of the photographs.

(446) The questions are numbered and a response, with a description of the test procedures used and our conclusions, follows each question. Illustrations are included with some of the responses. The first number in each illustration caption is the same as the number of the corresponding question. Three illustrations are also included as part of this introduction. Figure RIT 0-1 serves to identify the three different views of Oswald and the only negative that has been located. Figures RIT 0-2 and 0-3 are enlargements of two of the views which the reader may find useful for reference purposes. A glossary is included as an appendix for readers who are unfamiliar with any of the photographic terms used in this report.

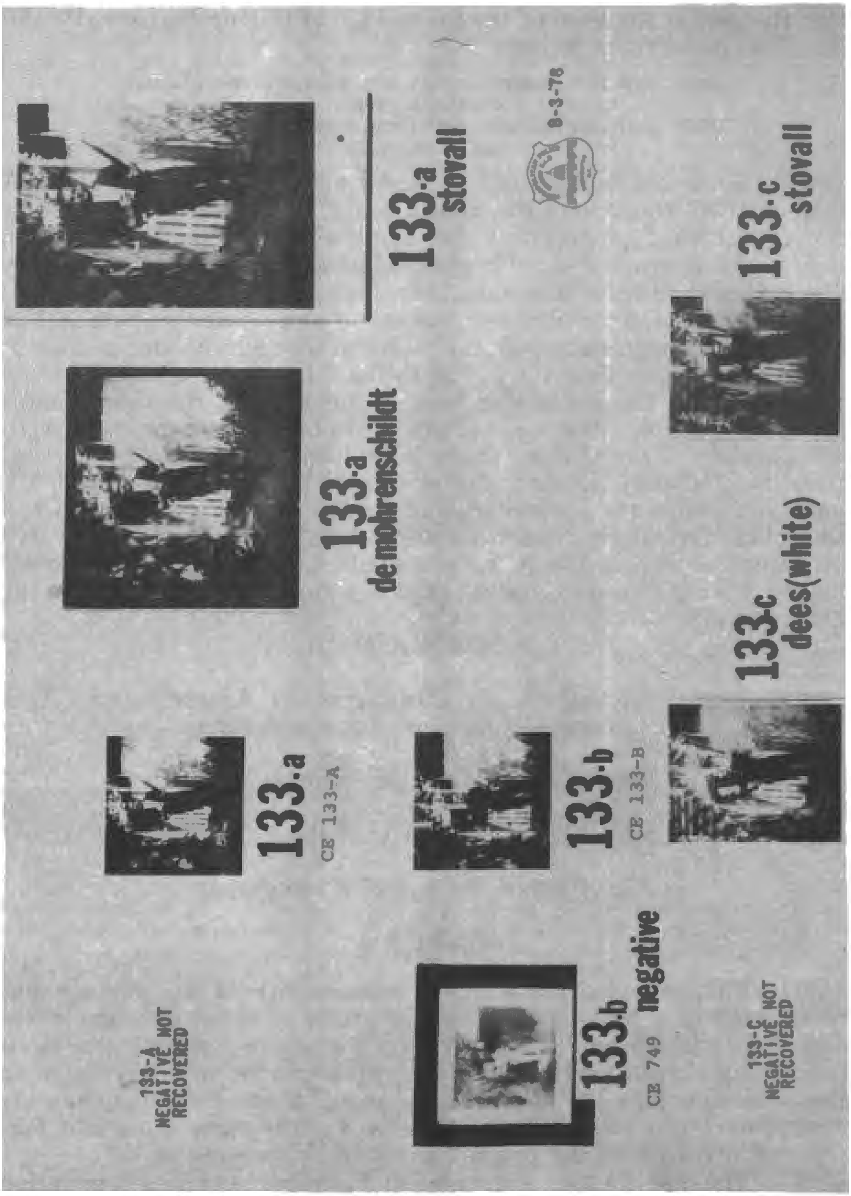


FIGURE RIT 0–1.—Identification of the three different views of Oswald in a backyard and the only negative recovered.

FIGURE RIT 0–2.—An enlarged copy print of original print CE–133B.

FIGURE RIT 0–3.—An enlarged copy print of original print CE–133A.

OSWALD BACKYARD PHOTOGRAPHS—QUESTIONS AND RESPONSES

(447) 1. Was the negative of Oswald exposed in the Oswald camera? (The negative is identified by the Archives number CE–749, and it corresponds with the print identified by the number CE–133B. The Oswald camera is an Imperial Reflex duo lens camera that uses 620 size film.)

(448) When negatives that were exposed in the Oswald camera by the undersigned were compared with the negative of Oswald, similarities in the edge markings from irregularities in the film aperture and scratch patterns indicated that the negative of Oswald was exposed in the Oswald camera. In addition, variations in sharpness from the center to the edges, and pincushion distortion were similar on the original and comparison negatives.

(449) 2. Do the edge markings on the FBI print (made from a negative exposed in the Oswald camera by the FBI) agree with the edge markings on the negative of Oswald (CE–749)?

(450) We had intended to make a quantitative comparison of the edge markings on the various photographs, as suggested by a panel member, by alining pairs of edge markings, measuring the displacement at fixed intervals and calculating the standard deviation. Careful examination of a roll of film we exposed in the Oswald camera revealed that while the distinctive marks appeared consistently on each frame of film, the straightness of the lines varied considerably—apparently due to slight buckling of the film. Instead, we made prints that compare pairs of edges on all four sides of the picture frame.

(451) By combining positive and negative images, it was possible to show the comparison as the two edges of a single black line. Figure RIT 2–1 shows a comparison between a print made by the FBI from Archives negative CE–749 (outside edge) and a print made from the the same negative at RIT (inside edge). In order to show all four edges it is necessary to make the inner image slightly smaller than the outer image, resulting in a slight displacement of markings near the ends of each edge. The distinctive markings on the inner and outer edges of the black line agree closely as would be expected if the two prints were both made from the same negative.

(452) There are two obvious discrepancies that we consider to be insignificant. (1) When one edge of the two images is alined, there is a slight lack of parallelism on the other three edges. Since the two prints were made with two different enlargers, any deviation from exact parallelism of the negative and the easel on either enlarger, a not uncommon defect in enlargers, would produce this effect. (2) There is an obvious difference in the vertical to horizontal proportions of the two images. The dimensional stability of photographic paper during processing and drying is different in the direction of the paper grain as opposed to across the paper grain. The difference in proportions is consistent with expectations if the paper grain were oriented vertically on one print and horizontally on the other.

(453) Figure RIT 2–2 shows a comparison between a print of an unidentified man on a roof made from a negative exposed in the Oswald camera by the FBI (outside edge) and a print of Oswald made from Archives negative CE–749 by the FBI. The similarities of the markings indicate that both were made with the Oswald camera. Figure

RIT 2–3 shows a comparison between film exposed in the Oswald camera at RIT (outside edge) and the Archives negative of Oswald, CE–749. Again, the distinctive markings are in close agreement indicating both negatives were made in the same camera.

(454) 3. Are the edge markings produced by the Oswald camera unique or are they similar to markings produced by other samples of the same brand of camera?

(455) When two other samples of Imperial Reflex duo lens cameras, obtained from the International Museum of Photography at the George Eastman House (IMP–GEH), were compared with the Oswald camera, it was found that all of the bodies were produced by injection molding of plastic. This produced three circular indentations on each side of the film aperture that tended to distort the otherwise essentially straight edge. The details of the distortions in these areas, however, were distinctively different on the three cameras. These differences in shape can be seen by examining the images through a low power (5–10X) magnifier. The most distinctive differences, however, are the two projections, one on each side, near the bottom of the Oswald camera image which are missing on the two IMP–GEH cameras. Figure RIT 3–1 shows a comparison between one of the IMP–GEH cameras (inside edge) and a negative exposed in the Oswald camera at RIT.

(456) 4. Does the image sharpness at the center and edges of the negative of Oswald (CE–749) appear to be consistent with that of other negatives made with the Oswald camera?

(457) Yes. Photographs taken with the Oswald camera by the undersigned revealed strong curvature of field, which accounts for much of the falloff in sharpness toward the edges. Photographs made with the two IMP–GEH Imperial Reflex duo lens cameras also revealed strong curvature of field. These cameras have no focusing adjustment and no aperture adjustment to control depth of field. With curvature of field the camera focuses on nearer objects at the edges of the picture than in the center. At the distance Oswald was standing from the camera, he appears sharper than objects near the edges at approximately the same distance. If the camera had been moved somewhat closer to Oswald, however, curvature of field would cause him to appear less sharp than objects at the edges which were at the same distance. Thus, the relative sharpness at the center and edges of photographs made with these cameras varies with the object distance. In figure RIT 4–1, the curved plane of sharp focus in object space is behind the wall in the center causing unsharpness in this area, is at the wall in a circular area midway between the center and the edges producing a sharp image, and is in front of the wall at the edges again causing unsharpness.

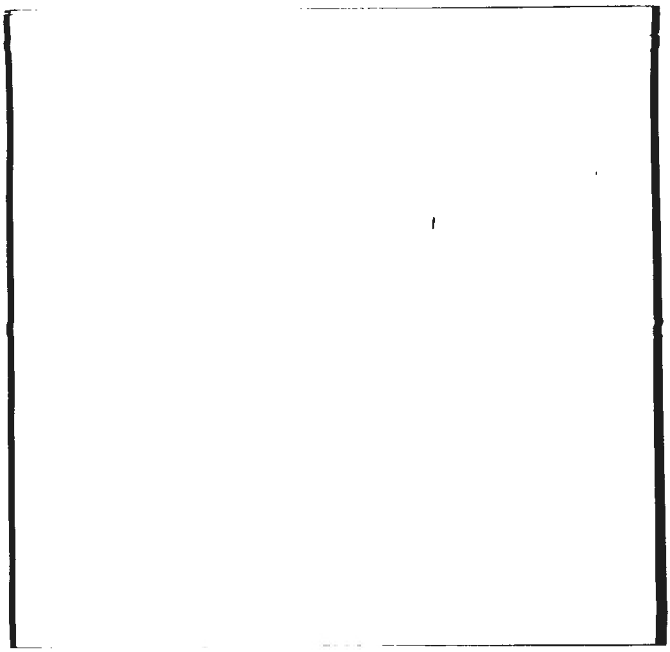


FIGURE RIT 2–1.—Comparison of edge markings on a print made by the FBI from Archives negative CE–749 (outside edge of black line) and a print made from the same negative at RIT (inside edge).

FIGURE RIT 2-2.—Comparison of edge markings on a print made by the FBI from a negative exposed in the Oswald camera by the FBI (outside edge) and a print of Oswald made from Archives negative CE-749 by the FBI (inside edge).

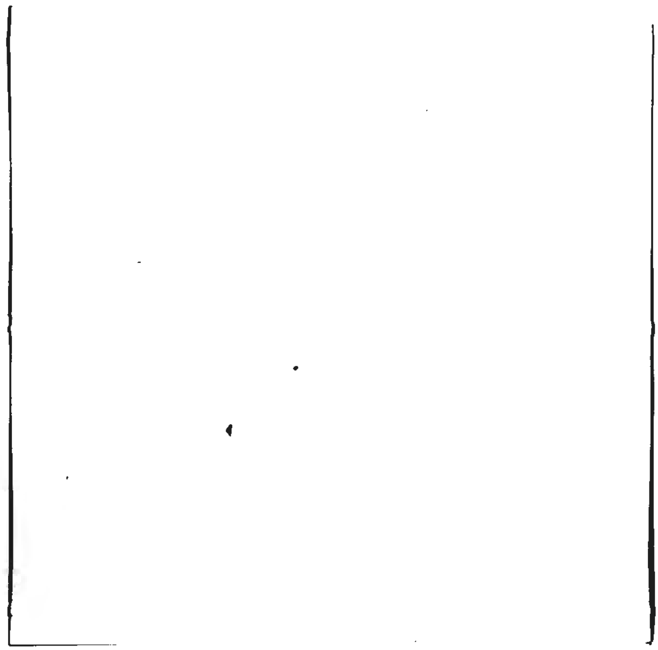


FIGURE RIT 2–3.—Comparison of edge markings on a negative exposed in the Oswald camera at RIT (outside edge) and the Archives negative of Oswald, CE–749, (inside edge).

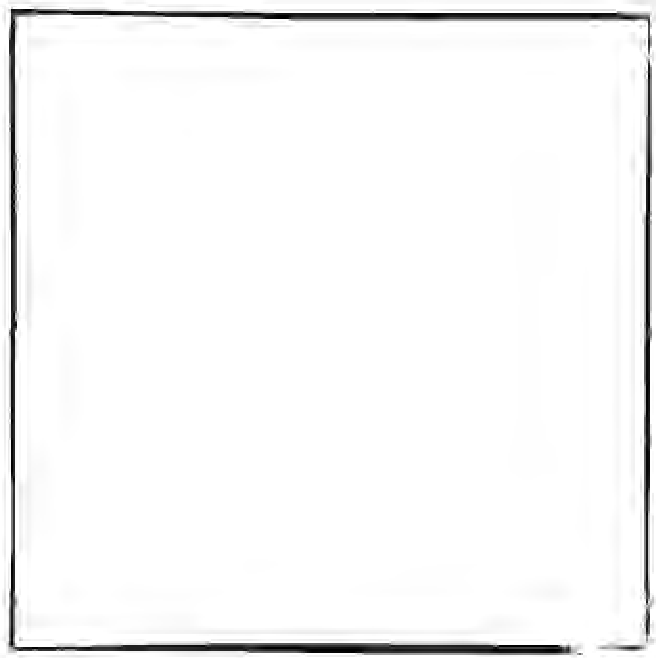


FIGURE RIT 3–1.—Comparison of edge markings on a negative exposed in an Imperial Reflex duo lens camera owned by the International Museum of Photography at the George Eastman House (inside edge) and a negative exposed in the Oswald camera at RIT (outside edge).

42-370 O - 79 - 13

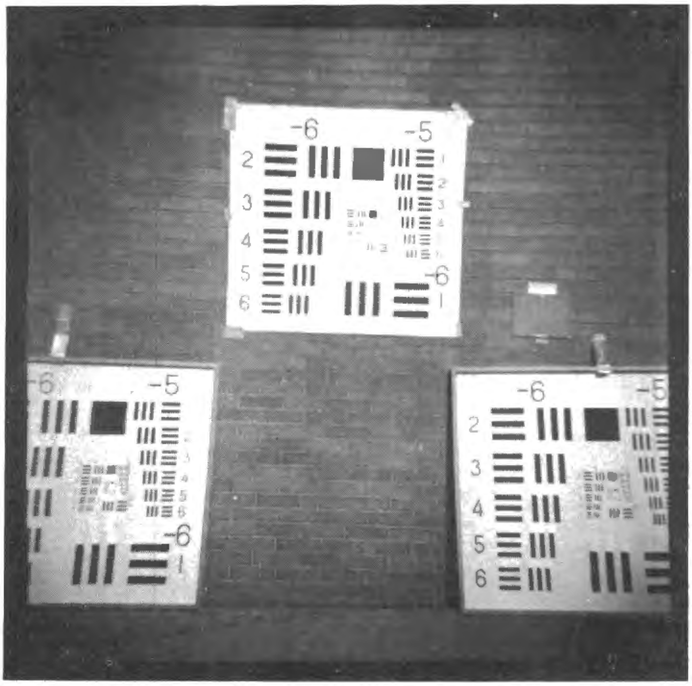


FIGURE RIT 4-1.—Photograph made in the Oswald camera at RIT illustrating curvature of field of the camera lens. The camera is focused behind the wall in the center and in front of the wall at the edges. The sharpest focus at the wall is in a circular area midway between the center and the edges.

(458) 5. Could the scratches on the negative of Oswald have been produced by the Oswald camera?

(459) Film exposed in the Oswald camera by the undersigned revealed scratches similar to those on the original negative of Oswald. Some scratches did not extend the full length of the film, but when 8 x 8 inch prints made from the original negative and one of the above comparison negatives were carefully alined, four prominent scratches were in the same locations on both prints—at 36, 45, 52, and 112 mm from the left edge of the picture area (fig. RIT 5-1). Scratches were detected on both the emulsion side and the base side of the negative of Oswald (CE-749), but the scratch lines that are evident on the prints correspond to those on the emulsion side of the negative. The fact that four prominent scratches were in the same locations on a print made from the negative of Oswald and a print made from a negative we exposed in the Oswald camera completely satisfied us that the scratches on the negative of Oswald were produced by the Oswald camera.

(460) 6. Do other samples of the same brand of camera produce similar or identical scratches?

(461) Obvious scratches were produced by one of the two Imperial Reflex duo lens cameras obtained from IMP–GEH but not by the other (figs. RIT 6–1 A and B). The camera that produced the obvious scratches had a badly warped back that put excessive pressure on the film and made it difficult to advance the film. The scratch pattern produced by this camera was not at all similar to that produced by the Oswald camera. We conclude that film scratching with this brand of camera is not the result of a manufacturing defect, in which case similar scratch patterns could occur with different cameras, but rather is the result of changes that may occur on an individual basis as the cameras are used over an extended period. It seems that the plastic used in the camera body and back can soften and be deformed when subjected to elevated temperatures, as was evident on one of the two IMP–GEH cameras, placing excessive pressure on the film as it is advanced in the camera.

FIGURE RIT 5–1A.—Print made from the negative of Oswald (CE–749) for scratch comparison with a negative exposed in the Oswald camera at RIT. Four prominent scratches were found to be in the same locations on both prints.

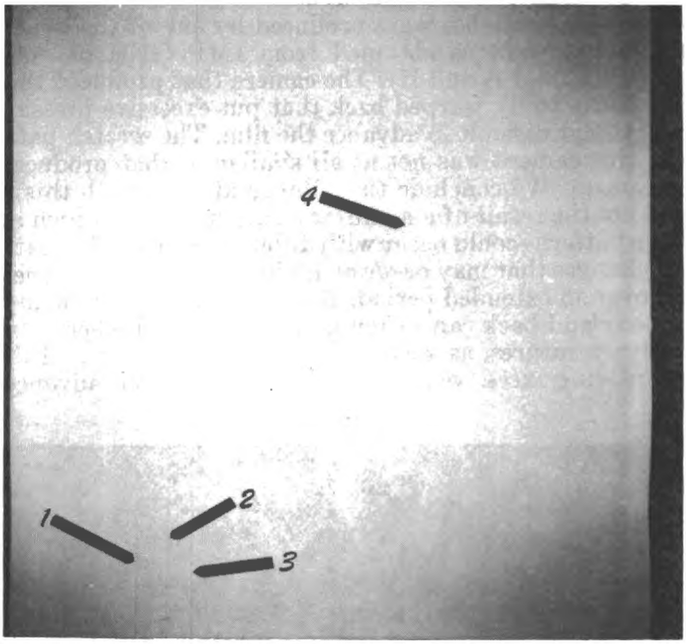


FIGURE RIT 5–1B.—Print made from a negative exposed in the Oswald camera at RIT, at the same scale of reproduction as the accompanying print made from the negative of Oswald.

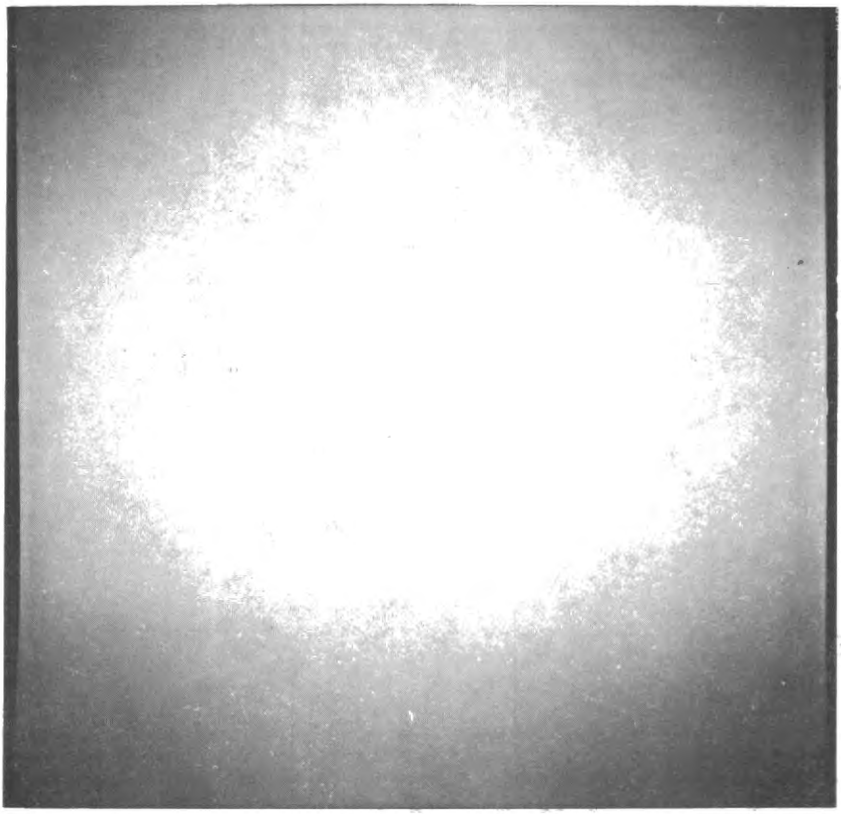


FIGURE RIT 6–1A.—Print made from a negative exposed in the first of two Imperial Reflex duo lens cameras owned by IMP–GEH. This camera had a badly warped back. The scratches are in different locations than those on prints made from negatives exposed in the Oswald camera.

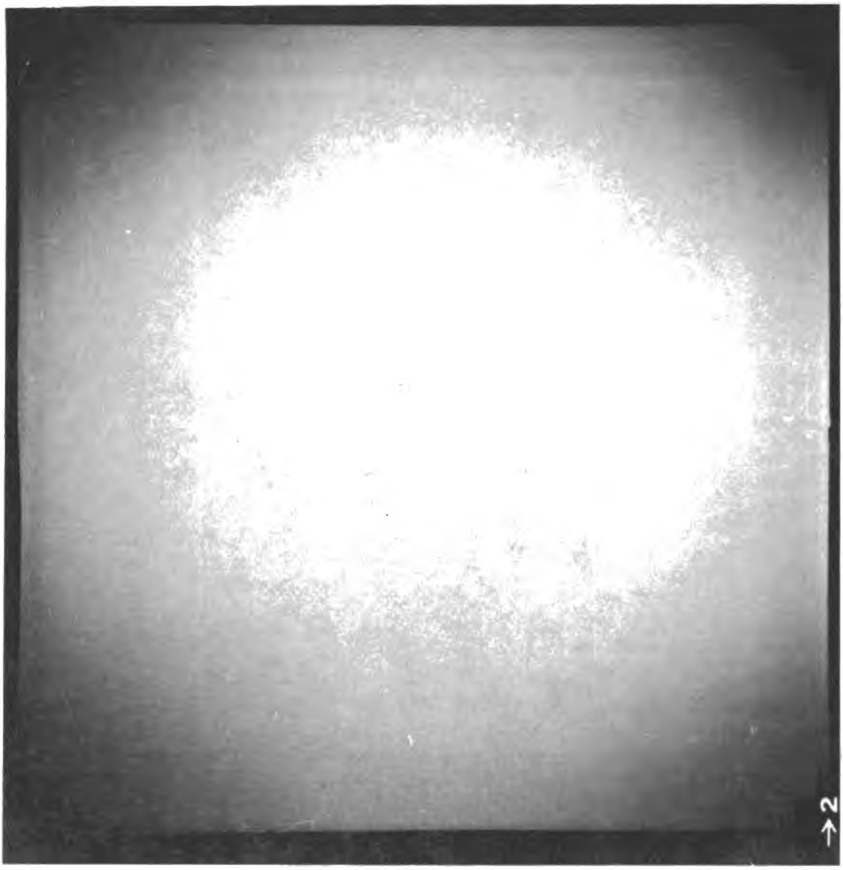


FIGURE RIT 6-1B.—Print made from a negative exposed in the second IMP-GEH camera. Only faint, transient scratches were produced by this camera.

(462) 7. Can the scratches on the negative of Oswald be enhanced?
(463) There are procedures for enhancing scratches. Since it was felt that a positive identification had been made in the response to question 5 above, these procedures were not employed. Also, we noticed that the fine scratches on the film we exposed in the Oswald camera tended to be less continuous than the four obvious scratches we measured and therefore they would be less useful for identification purposes.
(464) 8. Are any scratches continuous on the body, head, and background on the negative of Oswald?
(465) Apparently there was concern about the scratches not only for the purpose of determining if the negative of Oswald had been exposed in the Oswald camera (discussed in 5 and 6 above) but also to provide information concerning the possibility that a composite image had been made—such as a head or figure from one photograph and the remaining parts from another. For this second purpose, a continuous scratch on the head, body, and background would limit the options by which a composite could have been made. If, for example, a scratch were detected running from the top edge to the bottom edge of a print but stopping abruptly at the head, there

would be reason to suspect that a head had been transplanted from another photograph. Or, if such lines were detected on the negative of Oswald but they were evident only as light or dark streaks with no indication of physical damage to the film surface, there would be reason to suspect that the negative was a copy negative rather than an original, and that some fakery was involved. No evidence of such scratch marks was detected. In the present case, since it could be seen that the scratches were actually on the surface of the negative of Oswald, they simply confirm these marks were caused by the camera and, as such, that the negative was indeed exposed in the Oswald camera. None of these scratch marks were suggestive of compositing. Similarly, the scratch marks on the prints were caused by the effect of the camera on these negatives, and thus are not evidence of fakery but rather serve to confirm that Oswald's camera was used to take these pictures.

(466) 9. Are there any differences in the grain pattern in the areas of the body, head, and background on the negative of Oswald?

(467) No inconsistencies could be detected between the areas mentioned with examination of the original negative through a 30X magnifier, on normal contrast enlarged prints, or on high contrast enlarged transparencies (figs. RIT 9-1 A and B).

(468) 10. Are the backgrounds identical in the three different views of Oswald in the backyard (CE-133A, CE-133B, and CE-133C)?

(469) The backgrounds are not identical on the three photographs, but the differences are those to be expected as a result of a change in the position or the angle of the camera with respect to the scene. We could not detect anything that would suggest the background itself (as distinct from the photographs of the background) had been changed in any way—as by the addition, removal, or alteration of any of the parts. Also, we could not detect any evidence of fakery either in the background areas of the photographs or in the figures. (Also see question 15 below.)

(470) 11. Are the nose shadows compatible with the other shadows in the scene?

(471) The positions of the shadows under the nose, eyebrows, and chin all appear to be consistent with the other shadows in the scene. In addition, the sharpness of the edges of the shadows and the contrast of the shadows with the surrounding areas appear to be consistent.

(472) We were subsequently asked to respond to the statement in the caption on page 191 of *JFK: The Case for Conspiracy* by F. Peter Model and Robert J. Groden, which compared CE 133-A and 133-B. "In the bottom photo [CE 133-B], Oswald's head is cocked slightly to his left, yet the shadow directly under his nose (see top closeup of CE 133-A) moves—not in relation to the light source but to the angle of his head."

(473) It is true that if the tilt of the head were the only change made between the two photographs, the nose shadow would point more toward the left side of Oswald's mouth (on the viewer's right) in CE 133-B where the head is tilted. However, turning the head from left to right (as distinct from tilting it) also alters the placement of the nose shadow. The authors understandably did not take this factor into account because Oswald's head seems to be facing directly toward the camera on both photographs. In actuality, however, the position of Oswald and/or the camera has changed slightly as evidenced by the

change in the position of the post behind Oswald. If we assume that the camera was moved a short distance to the viewer's left for CE 133–B, Oswald would have to turn his head to his right in order to be facing the camera and this would move the shadow back toward the original position shown in CE 133–A. Also, moving the camera to the left or moving Oswald to the viewer's right would produce the observed change in the relative positions of the post and Oswald's head.

FIGURE RIT 9–1A.—Enlarged print on normal-contrast photographic paper from the negative of Oswald (CE–749), used to determine if there are any differences in the grain pattern in the areas of the body, head, and background. No inconsistencies were detected.

FIGURE RIT 9–1B.—Enlarged transparency on high-contrast photographic film for grain pattern check. No inconsistencies were detected. (The original transparency provides the best detail when viewed by transmitted light.)

1. Head vertical. Shadow points toward center of mouth.

2. Head tilted. Shadow points toward left side of mouth.

FIGURE RIT 11.—Four photographs made to demonstrate that the change in the position of the nose shadow produced by tilting the head can be nullified by rotating the head as an explanation for the similarity in the positions of Oswald's nose shadow in views CE–133A and CE–133B.

3. Head tilted and rotated. Shadow points toward center of mouth, but head is not facing camera.

4. Moving camera to left restores full front view. Shadow points toward center of mouth with head tilted.

(474) Four photographs were made of a manikin head to illustrate the explanation given above:

Figure RIT 11–1. The nose shadow falls straight under the nose with the head in the vertical position.

Figure RIT 11–2. Tilting the head to the viewer's right by placing a pencil under the opposite side causes the nose shadow to move noticeably toward the left side of the manikin's mouth.

Figure RIT 11–3. Rotating the head to its right returns the shadow to the original position, but the manikin is no longer facing the camera.

Figure RIT 11–4. Moving the camera to the left produces a full front view of the head with the shadow in the original position even though the head is tilted. Also, the background has moved to the left in comparison with the head, as in the photographs of Oswald.

(475) 12. Is there any evidence of a line in the chin and neck area that would suggest the picture is a composite?

(476) We found no evidence of a line suggesting a composite had been made in our examination of the only original negative available (CE–749) (without magnification and at 30X magnification) and of normal-contrast prints and high-contrast prints at either low or high magnification. We made a copy of the reproduction of a portrait of Oswald from page 192, "JFK: The Case for Conspiracy," by F. Model and R. Groden in which the authors claim the chin has been transplanted (fig. RIT 12–1). For comparison purposes we made enlargements at about the same scale from copy negatives of prints CE–133A, CE–133B, and CE–133C (fig. RIT 12–2). The enlargement of the head from CE–133C is less sharp than the other enlargements because when the original 8 x 10 inch print was made, the enlarger was not focused accurately, and the original negative has not been located.

FIGURE RIT 12–1.—Photographic copy of the reproduction of print of Oswald (CE–133A) in the book "JFK: The Case for Conspiracy" in which the authors claim the chin has been transplanted.

FIGURE RIT 12–2.—Enlarged copies of the three views of Oswald for comparison with the preceding illustration. Above is CE–133A.

(477) All three of these prints have light shadows on both sides of the dark shadow under the lower lip, but print CE–133A also has some irregular dark spots in the area where the line appears in the book illustration. Such spots could be caused by any of various natural factors, the most probable of which are shadows caused by the slight but obvious change in expression in the mouth area, random clumpings of silver grains which are evident at this magnification throughout the picture, and a slight change in the angle of the head with respect to the Sun.

(478) In any event, the dark spots on our print do not conform to a smooth line which would be the effect with the conventional procedures used in making composite images. A line can also be seen on the forehead of this photograph (CE–133A) which does not appear in CE–133B nor in the book illustration. The picture that appears in the book was made with high-contrast film or paper, an appropriate procedure for some purposes but it produces a misleading effect here in that it exaggerates some details and eliminates others. Observe that the laugh lines running down and out from the sides of the nose, which are plainly visible on our normal contrast print, have disappeared in the book illustration. We are convinced that there is no fakery associated with the spots on the chin.

(479) 13. Are there any pictorial inconsistencies that suggest faking?

(480) Careful examination of the photographs with respect to lighting, perspective, sharpness, distortion, grain pattern, density, and contrast revealed no evidence of fakery. Examples of evidence of fakery concerning the lighting would be shadows in the wrong position in relation to the position of the Sun and the object casting the shadow, shadows that do not correspond in shape to that expected when shadows are projected onto another surface, shadows that do not appear as sharp as expected with direct sunlight, shadows that do not appear as dark as expected with the approximately 1 : 8 lighting ratio between the shadow and highlight sides of objects obtained in sunlight on a clear day, and shadows that do not respond to nearby reflecting surfaces. No such discrepancies are seen in any of the three photographs of Oswald. The darkness, shape, sharpness, and placement of the shadows appear to be correct.

(481) The effect of light being reflected from the white surfaces on the left can be seen in the shadow on that side of Oswald's neck, and the shadow of Oswald on the ground moves appropriately as he changes his position between each of the photographs. Tilting the camera slightly downward for view CE–133A where Oswald is holding the paper under his chin, produces the expected higher placement of the figure in the picture and the divergence of the vertical subject lines toward the top of the picture.

(482) Composite photographs made using a pasteup or montage technique can usually be detected as such unless the component parts are made under identical conditions and with great skill. Clues that commonly reveal fakery are mismatches of the density, contrast, sharpness, graininess, perspective, and lighting, and imperfect blending of the edges between the parts. No such clues can be found in these photographs. Furthermore, there is no disruption of the grain pattern across the boundary between the head and the body or between the head and the background so that any composite photograph involving the head would require using large original negatives and prints and then copying the composite image with the Oswald camera. This possibility is discussed in the response to question 22, but nothing in the negative or the three prints of Oswald was detected that appears inconsistent or suggests fakery.

(483) Additional questions related to statements by Mr. Malcolm Thompson in a BBC film and a manuscript identified as "Panorama—Kennedy, Project number 5348/5506" that is included in the appendix:

(484) 14. Does the apparent bulge in the left edge of the post to the right of Oswald's head appear to be due to retouching or other alteration of the image in photograph number CE–133B?

(485) What could be perceived as an indentation in the post in CE–133B is believed by the undersigned to be an illusion resulting from the location of a shadow of a branch or leaf along the left edge of the post. It follows that since the darker area to the left of the post is a shadow of the post on a white surface, a shadow falling on the white post would be similar in tone and could be seen as part of the background rather than as a shadow on the post. The shadows falling along the right edge of the post create a slight illusion that the right edge is not entirely straight either, even though the background to the right of the post is lighter in tone.

(486) Careful examination of this area on enlarged prints reveals a narrow object, that could be either a wire or a bush branch, running from the edge of the building on the right, in front of the post, across the area in question, and continuing through the shadow area between the neck and the post (fig. RIT 14–1). Anyone skillful enough to retouch the area between the neck and the post, as claimed by Mr. Thompson, and include the just-detectable wire or branch, would have no difficulty in producing a straight line on the post.

FIGURE RIT 14–1A.—Enlargement of a section of view CE–133B which shows what appears to be a wire or branch running through the shadow area to the right of Oswald's neck which Mr. Thompson claimed had been added to the photograph, producing an irregularity in the left edge of the post.

[These overlaying transparencies can only be analyzed by studying them in a viewer. For this reason, they have been retained in committee files.]

FIGURE RIT 14–1B.—Enlarged transparency on high-contrast film for check of line running through shadow area to the right of Oswald's neck. (The original transparency provides the best detail when viewed by transmitted light.)

(487) 15. Are the backgrounds and shadows identical on any of the three different views (CE–133A, CE–133B, and CE–133C), thereby suggesting that different figures have been superimposed on different prints of a single background photograph?
(488) The speculation is either that someone started with a photograph of a backyard with no figure and added the three figures from other photographs, or that Oswald's head was added to three photographs of someone else standing in the backyard. The backgrounds are not identical, thereby ruling out the possibility that figures were added to three prints of a single photograph of the backyard. The differences include changes in the convergence of vertical subject lines (the posts, the boards in the fence, and the building on the right) with changes of camera tilt, changes in the area of the background included in the three views, and slight changes in the positions of shadows of some branches and leaves.
(489) 16. Is there evidence that part of the background could have been moved photographically to fill a gap created by adding a figure in a different pose to a background photograph?
(490) No such evidence can be detected. Since the figure moved to the viewer's left between views CE–133B and CE–133A, and moved closer to the fence between views CE–133A and CE–133C, major gaps would have been created around the entire periphery of the figures if the figures had been added as suggested. Even if it is assumed that photographs of Oswald's head have been added to photographs of someone else's body, the necessary retouching around the edges would be difficult to conceal from detection with high magnification.
(491) 17. Is there evidence that the shadows have been touched in? No. The shadows appear normal in shape, location, sharpness, and contrast. It would be especially difficult to maintain realistic detail in the shadows on the ground if the shadows were added. It is noted that the shadow moves an appropriate distance to the left as Oswald moves to the viewer's left from view CE–133B to view CE–133A, and when he moves closer to the fence in view CE–133C the shadow moves up onto the fence as expected. (The relative distances between Oswald and the fence can be determined by noting the position of his feet with respect to the shadows of the three overhead wires.)
(492) It is true that highly skilled artists can and have made paintings that appear photographic. There is no evidence, however, that this was done in this case. To add shadows having detail to a photograph requires not only darkening the appropriate area, but also changing the detail within the shadow so that it appears to be illuminated by diffuse illumination from the sky and surroundings rather than by the Sun. Therefore, the sharpness and position of the detailed shadows within the larger shadow area must be changed in sharpness and position. For example, there is a ridge at the top of the white wall behind Oswald that casts a shadow on the wall beneath it. Where the Sun

hits the ridge the shadow is sharp and contrasty. Where the ridge is in the shadow of the post, the shadow has a less sharp edge and the contrast with the adjacent area is lower. A similar situation exists where Oswald's shadow falls on what appears to be a paper on the ground near the fence. The soft shadows on the paper within the head shadow on view CE–133B appear as would be appropriate if illuminated with diffuse light from the fence and sky.

(493) 18. Is the size or position of the shadow of the gun in Oswald's right hand (view CE–133B) inconsistent with the position of the gun?

(494) If the gun were held vertically with the butt on the hip, we would expect the shadow to be oriented in the same direction as the shadows of the legs. However, the barrel of the gun is tilted toward the left side of the picture and also toward the camera. Both of these changes have the effect of rotating the shadow of the gun in a counterclockwise direction. The positions of the gun and the shadow are therefore compatible.

(495) 19. Is there evidence that Oswald's left arm and hand have been stuck on to another photograph in a physiologically inconsistent manner (view CE–133B)?

(496) It is possible to experience an optical illusion whereby the small wedge of the bare upper arm that is visible between the bottom edge of the dark sleeve and the lower arm appears to be part of a horizontal limb attached to the rib cage. This is an illusion not unlike the illusion in view CE–133A that the post is sitting on or growing out of Oswald's head. It is just as easy to see the small wedge of the bare upper arm as being part of a vertical limb that is mostly enclosed in the shirt sleeve. Moreover, it is difficult to understand the purpose of making a composite image in this manner.

(497) 20. Is the area between Oswald's neck and the post to the viewer's right (view CE–133B) too wide to be filled by a shadow of the post, thereby indicating retouching?

(498) The ratio of the shadow width to the post width was calculated for view CE–133A, where both are clearly visible, and was found to be 1:1.07. Applying the same ratio to an enlarged print of view CE–133B, where the post is 24 millimeters wide, the calculated width of the partly concealed shadow is 22.4 millimeters. The measured distance between the neck and the post is 22 millimeters if the apparent indentation is included, and only 20 millimeters to the position of a straight left post edge. Therefore, the distance between the neck and the post is not too wide to be filled by a shadow of the post.

(499) 21. Are the heads on any two of the three different views (CE–133A, CE–133B, and CE–133C) from a single original photograph?

(500) One method of detecting differences between two photographs is to place them in a stereoscope so that the left eye sees one photograph and the right eye sees the other. If the two photographs are identical, the two images will fuse and the viewer will perceive a single image. If the photographs are not identical, the areas of disparity will not fuse and the viewer will perceive two separate images. When the three views of Oswald were viewed two at a time in a stereoscope, it became apparent that no two of the images were identical.

(501) The procedure used in the CBC film to demonstrate that the heads on two of the photographs of Oswald were identical was to superimpose enlarged monochrome color transparencies having different colors. The viewer was thereby led to believe that the transparencies registered exactly. In an effort to duplicate this demonstration, we made closeup copy negatives of the head areas in the three prints identified as CE–133A, CE–133B, and CE–133C. These negatives were enlarged to 8 x 10 inches to produce diapositive images on normal-contrast film and also on high-contrast film. Green and magenta positive images were then produced by contact printing.

(502) Superimposing the normal-contrast color images from the pairs of photographs as was done in the CBC film revealed that while this appears to be an elegant test, it is not very discriminating. The registration between the two images could be altered considerably before any color fringing became apparent in the facial features. An explanation for this registration tolerance is that the facial details that appear sharp on a small print are revealed to have unsharp edges when enlarged to this size due to the granular composition of the photographic image. A close examination of the superimposed images revealed a difference in the grain structure, but color differences were obvious at a normal viewing distance only in the large areas of disparity in the background and under the head (fig. RIT 21–1).

[These overlaying transparencies can only be analyzed by studying them in a viewer. For this reason, they have been retained in committee files.]

FIGURE RIT 21–1A.—Superimposed normal-contrast green and magenta transparencies of pairs of the three views of Oswald reveal obvious color differences only in the large areas of disparity in the background and under the head. This is the procedure used in a CBC film to demonstrate that the heads on the photographs are identical. Above, CE–133A and CE–133B. (The original transparencies should be viewed by transmitted light. They are on file in the National Archives.)

FIGURE RIT 21–1B.—CE–133B and CE–133C.

FIGURE RIT 21–1C.—CE–133A and CE–133C.

FIGURE RIT 21–1D.—Both the green and the magenta transparencies were made from CE–133A to demonstrate that no color differences are seen even in the background with identical images.

(503) Two additional procedures were then used in an effort to verify and then provide evidence that the heads on the three photographs are not identical. For one, positive and negative high-contrast film images were sandwiched together and contact printed onto paper. When the positive and negative images are from the same original photograph (CE–133B) a fine-line effect is produced as shown in figure RIT 21–2. When the positive image from CE–133B is combined with the negative image from CE–133A, the areas of disparity are represented either as broader black areas or as broken lines. This print is shown in figure RIT 21–3. Similar comparisons of CE–133A and CE–133C, and of CE–133B and CE–133C are shown in figure RIT 21–4 A and B.

(504) It should be mentioned here that the head sizes were not identical on the original prints from the Archives. An adjustment was made when the copy negatives were enlarged to make the 8 x 10 inch diapositives. The widths of the images were matched at the temples and cheekbones, but the vertical-horizontal proportions are noticeably different. We attribute this change in the shape of Oswald's head to the downward tilt of the camera for photograph CE-133A, that placed the head farther off the lens axis. This effect is explained in greater detail below.

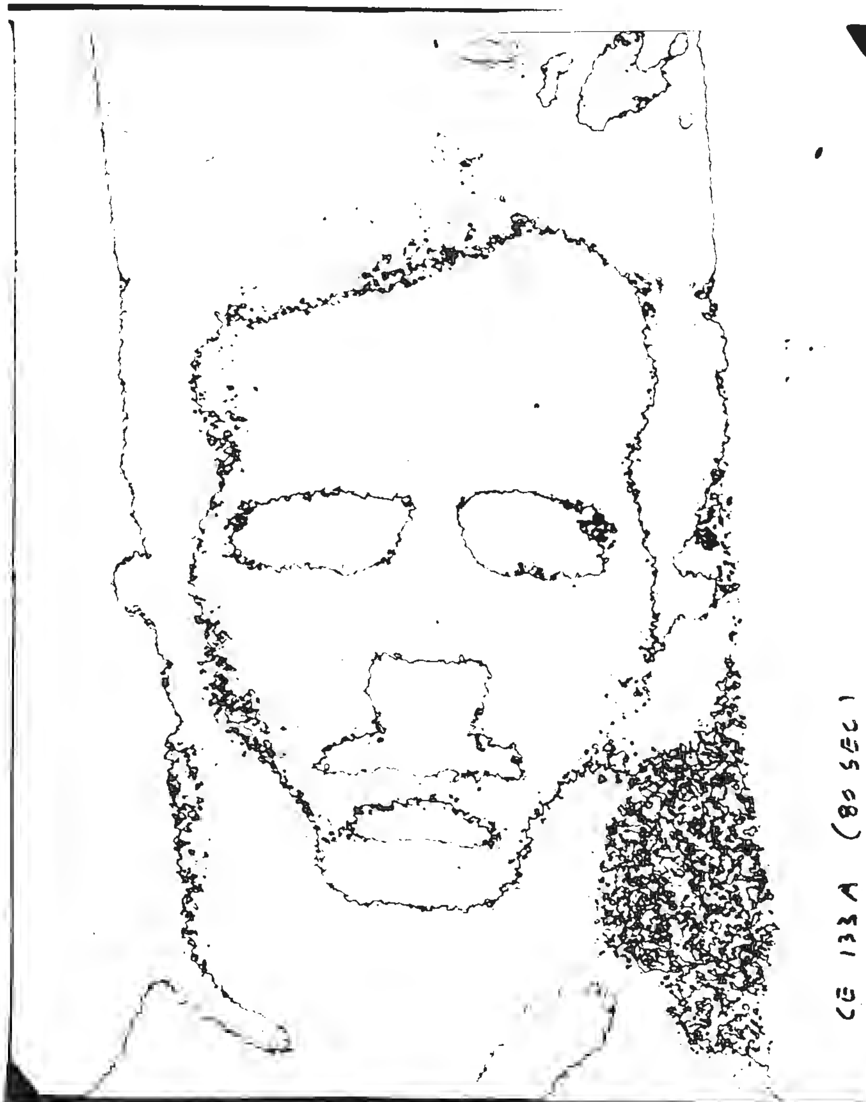


FIGURE RIT 21-2.—Print made from superimposed high-contrast positive and negative film images of view CE-133B to demonstrate that a fine-line effect is produced when the high-contrast images are made from the same original.

FIGURE RIT 21-3.—Comparison of CE-133A and CE-133B. The areas of disparity are represented either as broader black areas or as broken lines.

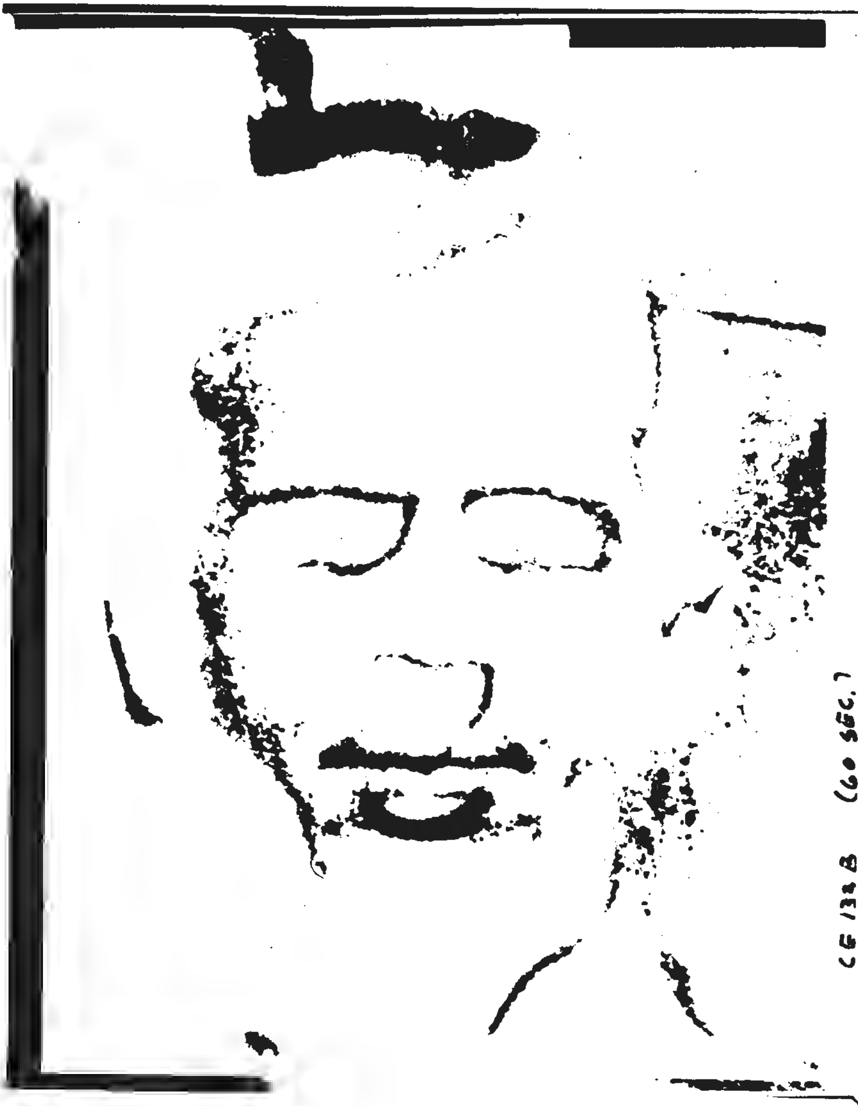


FIGURE RIT 21–4A.—Comparison of CE–133A and CE–133C.

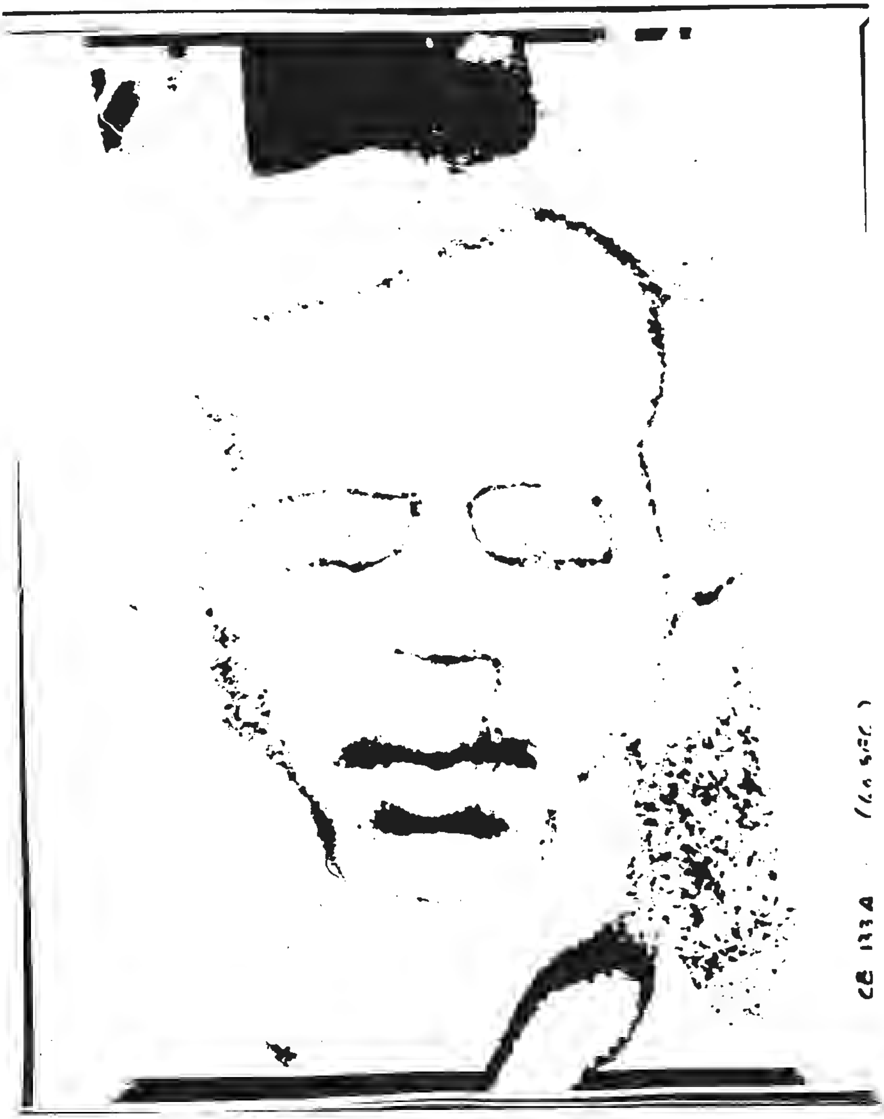


FIGURE RIT 21–4B.—Comparison of CE–133B and CE–133C.

(505) In addition to the change in the outline shape of the head, the disparity between the images in the area of the nose, mouth, and shadow under the mouth is quite obvious. We attribute these differences to a slight change in expression around the mouth and a slightly different angle of the head with respect to the Sun and the camera. The chin shadow appears in the shape of an inverted "U" in CE–133B and an upright "U" in CE–133A.

(506) For the third and final procedure demonstrating that the heads on the three photographs are not identical, green and magenta transparencies were made from the positive and negative high-contrast film images. When the green image from CE–133B is properly registered

(i.e., superimposed) on the magenta image from CE–133A and the two are opposite in negative-positive polarity (i.e., one is a negative image and the other is a positive image), the areas of disparity become evident as clear areas and as areas of a darker color produced by the overlap of green and magenta. We believe the differences are dramatic and clearly indicate that the two heads did not come from a single original photograph. This pair of images is shown in figure RIT 21–5. Similar results were obtained when high-contrast color images from view CE–133C were superimposed on those from views CE–133A and CE–133B (fig. RIT 21–6). An additional pair of green and magenta transparencies, both made from view CE–133B, is included to show the appearance of identical images in figure RIT 21–7.

[These overlaying transparencies can only be analyzed by studying them in a viewer. For this reason, they have been retained in committee files.]

Figure RIT 21–5.—When a green negative high-contrast image from CE–133B is superimposed on a magenta positive high-contrast image from CE–133A, the areas of disparity become evident as clear areas and as areas of a darker color produced by the overlap of green and magenta. (The original color transparencies should be viewed by transmitted light.)

Figure RIT 21–6A.—Superimposed high-contrast color images from CE–133B and CE–133C.

Figure RIT 21–6B.—Superimposed high-contrast color images from CE–133A and CE–133C.

Figure RIT 21–7.—Superimposed high-contrast color images, both from CE–133B, to illustrate the effect obtained with identical original images.

(507) Additionally, photographs were made of a manikin head with an Imperial Deluxe Reflex duo lens camera similar to the Oswald camera, placing the image of the head in various positions from the center of the negative to the edges. The purpose of this was to illustrate the effect such variations in placement have on the shape of the image of the head in order to explain the differences in head shapes in photographs CE–133A, CE–133B, and CE–133C, observed when the high-contrast color transparencies were superimposed. A black-and-white contact print of three negatives (fig. RIT 21–8) shows the manikin head in the center of the photograph, near the top (tilting the camera down), and near the top left corner (tilting the camera down and aiming it to the right). Placing the image of the head off the lens axis causes it to be elongated in a direction radiating away from the center of the photograph. Thus, the head at the top of the photograph is stretched vertically and the head in the corner is stretched diagonally. This change in shape can be seen on the contact print, but the heads were also enlarged on high-contrast film and contact color transparencies were made so that direct comparisons could be made by superimposing green and magenta pairs of the three images (fig. RIT 21–9).

(508) This change in shape is known as the wide-angle effect and it occurs with all conventional camera lenses including normal, wide-angle, and telephoto, but it is most obvious with short focal length wide-angle lenses. In addition, pincushion distortion, which is evident in the curved reproduction of straight subject lines, and the altered

perspective, which is evident in the convergence of vertical subject lines when the camera is tilted, slightly affect the shape of the head. (The differences in sharpness of the images of the manikin head when placed in the center and near the edges of the photograph is further evidence of curvature of field observed in photographs made with the Oswald camera.) Thus, the difference in height to width proportions of the heads in CE–133A, CE–133B, and CE–133C can be explained in terms of these effects since the tilt of the camera changed between the photographs, thereby placing the head in different positions. Of the three effects mentioned, the wide-angle effect has the greatest influence on the shape of the head. Since the wide-angle effect applies only to three-dimensional objects, it would not alter the shape of a two-dimensional head on a photographic poster or print, the use of which has been suggested as a way of faking the photographs of Oswald. Thus, the presence of this effect in the backyard picture is another item of evidence negating the likelihood of fakery.

(509) 22. Could the negative of Oswald be a copy of a composite print rather than an original photograph?

1. Image in center with camera level. Shape of head is normal.
2. Image at top with camera tilted down. Head is elongated vertically.
3. Image in corner with camera tilted down and rotated to the right. Head is elongated diagonally, away from the center.

[These overlaying transparencies can only be analyzed studying them in a viewer. For this reason, they have been retained in committee files.]

FIGURE RIT 21–8.—A contact print of three negatives made with an Imperial Reflex duo lens camera to show the effect of variations of image placement within the picture format on the shape of a head.

FIGURE RIT 21–9.—Enlarged high-contrast positive color transparencies of the three photographs in the preceding illustration, superimposed to reveal areas of disparity. (The original transparencies should be viewed by transmitted light.)

FIGURE RIT 22–1A.—An original photographic print that was copied with the Oswald camera to determine if the reproduction (following illustration) would be acceptable as an original photograph.

FIGURE RIT 22–1B.—A copy photograph made with the Oswald camera that has characteristics of an original photograph including the camera scratch pattern. The left border of the original print shows even though it was not visible in the camera viewfinder; the photograph also reveals exaggerated pincushion distortion due to use of a supplementary lens over the camera lens.

(510) The undersigned copied a photographic print with the Oswald camera, using a +4 diopter supplementary lens over the camera lens, to demonstrate that it is possible to make a copy negative that has characteristics of an original negative including edge markings, scratch patterns, variations in center to edge sharpness, pincushion distortion, and consistent grain patterns (fig. RIT 22–1 A and B). For this type of fakery to be successful, it would be necessary to use a large format camera with a good quality lens for the original photographs to avoid introducing graininess, scratches, unsharpness, or distortion at this stage. Also, any alterations would have to be made on large photographs so that retouching or discrepancies could be concealed. Furthermore, the Oswald camera would have to be available to the person making the fake photographs and it would be necessary to cal-

culate a combination of supplementary lens focal length and original print size to obtain an in-focus image of the desired size with the fixed-focus camera.

(511) Clues that might uncover this type of fakery would include strong pincushion distortion caused by adding a supplementary lens, loss of gradation in highlight areas and loss of detail in shadow areas which typically occurs when copies are made, and possible detection of imperfect retouching or other alterations. Pincushion distortion was much more evident on the copy photograph made with the Oswald camera than on the original negative of Oswald or on other photographs made with the Oswald camera without the supplementary lens. Since there is no wide-angle effect when two-dimensional photographs are copied, to avoid detection of fakery, appropriate variations in the shape of Oswald's head would have to be incorporated in the original photographs. In summary, it is possible to make copy photographs that are acceptable as originals. Nevertheless, because such a process poses many technical problems, any one of which if not solved would lead to detection under close examination of the photographs, we do not believe such a procedure was used to produce the three backyard photographs of Oswald.

ATTACHMENT A

GLOSSARY OF PHOTOGRAPHIC TERMS [1]

Composite image.—A photograph in which two or more separate images have been combined by any camera, printing, or post-printing technique—for example, camera montage, film stripping, printing montage, and pasteup.

Contact printing.—To expose photographic paper or other sensitized material through a negative or transparency while the two are pressed together for the purpose of making a reproduction that is the same size as the original.

Contrast.—The actual (objective) or the perceived (subjective) variation between two or more parts of an object or image with respect to any of various attributes such as luminance or hue. Subjective contrast is commonly described in general or relative terms such as high contrast or lower-than-normal contrast. Normal-contrast films generally represent luminance differences in the subject with corresponding density differences in the negative whereas high-contrast films record most of the subject tones as a uniform high density and a uniform low density.

Copy negative.—A negative produced by photographing a photograph as distinct from a negative produced by photographing an original scene.

Curvature of field.—A lens defect in which the sharpest image of a subject plane assumes the shape of a curved surface rather than conforming to the flat surface of the photographic film or paper. If a lens with this defect is focused in the center of the film or paper the image will be out of focus in the corners, and if it is focused in the corners the image will be out of focus in the center.

[1] The illustrations and some of the definitions are from ***Dictionary of Contemporary Photography***, Leslie Stroebel & Hollis N. Todd, Dobbs Ferry, N.Y.: Morgan & Morgan, 1974, with the permission of the authors and the publisher.

Density.—A logarithmic measure of the light-absorbing characteristics of an image, filter, et cetera. (Perceptually, there is an inverse relationship between density of various areas in a photograph and perceived lightness, so that a shadow area that has high density is perceived as having low lightness.)

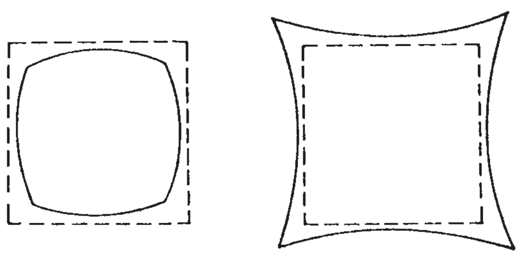
Depth of field.—The range of object distances within which objects are imaged with acceptable sharpness, for example, on a photographic print or transparency. Depth of field increases as the object distance, viewing distance, and f-number increase, and as the focal length decreases.

Diapositive.—(1) A transparency intended to be viewed or projected by transmitted light. (2) A positive image on a transparent or translucent support, used as an intermediate step in forming the final image. For example, a diapositive is made from an original negative to produce one or more duplicate negatives.

Dimensional stability.—The ability of film, paper, or other material to remain relatively unchanged in size when subjected to aging, processing, et cetera. Photographic papers may change dimensions by different amounts with the paper grain, and across the paper grain during processing.

Diopter.—A measure of lens power equal to the reciprocal of the focal length in meters. Plus and minus signs are used to denote positive and negative lenses, respectively. A +4 lens, for example, is a converging (positive) lens with a focal length of 1/4 meter or 250 mm. To a first approximation, the power of a lens combination is the sum of the powers of the components.

Distortion.—A lens condition that causes straight subject lines to bow inward or outward on the image (barrel distortion, pincushion distortion). This optical effect is caused by a variation of magnification across the field.



Barrel Distortion   Pincushion Distortion

Edge markings.—Masking irregularities around the edge of the picture area on film exposed in a camera that correspond to irregularities in the film aperture in the camera.

Film aperture.—An opening in a plate, located close to the film plane of a camera or a projector, that delimits the area of illumination. The plate adjacent to the film aperture in a camera supports the film and prevents exposure of the film beyond the picture format.

F number.—A number, such as f/11, obtained by dividing the focal length of a lens by the effective aperture. The f-number and the shutter speed are two basic exposure controls in cameras.

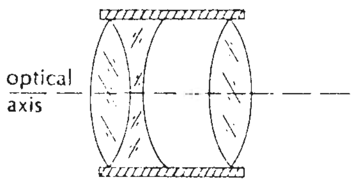
Focal length.—The distance from the rear nodal point of a lens to

the sharpest image of an object located at a very great distance on the lens axis. With camera lenses of normal design, the focal length is approximately the distance from the center of the lens to the film plane when the camera is focused on infinity.

Gradation.—A change in tone, texture, et cetera, between adjacent areas of an object or the corresponding image. Gradation provides the viewer with information concerning the form or depth of the subject, e.g., the facial features of a portrait subject as revealed by the lighting. Synonym: Local contrast.

Grain.—On black-and-white photographs, subject areas of uniform tone, such as blue sky, are composed of randomly distributed particles of silver. At low magnifications and large viewing distances the eye blends the small scale dark and light areas to produce a uniform tone. At high magnifications the nonuniformity can be seen as a clumping of the silver particles. The appearance of this clumping varies with a number of factors including the type of film, the exposure level, and development.

Lens axis.—A line joining the centers of curvature of spherical surfaces and perpendicular to plane surfaces. With camera lenses, the lens axis can be approximated as a straight line perpendicular to the lensboard and through the center of the front surface of the lens. Synonym: Optical axis.



Lensboard.—A panel that supports the lens on photographic optical equipment. Lensboards are detachable on most view cameras and enlargers to permit the substitution of other lenses.

Lighting.—The character or quality of the illumination as seen on a subject or in a photograph or a motion picture. Included among lighting variables are placement of the light source and the resulting placement of highlights and shadows, uniformity of lighting, lighting ratio, and shadow sharpness.

Lighting ratio.—A factor obtained by dividing the illuminance on the highlight side of an object by the illuminance on the shadow side. A lighting ratio of 3 to 1 is commonly recommended for studio portraiture, whereas the lighting ratio for an object in direct sunlight is typically 8 to 1.

Magenta.—A hue (color) obtained by mixing red light and blue light, or by removing green from white light.

Magnification.—A scale of reproduction larger than one. An 8 x 10-inch print made from a 4 x 5-inch negative without cropping would have a magnification of 2.0, obtained by dividing an image (print) dimension by the corresponding object (negative) dimension. In some contexts magnification refers to the ratio of the image size on the print to the size of the object being photographed irrespective of the image size on the negative.

Mask.—A device to protect specific areas of photosensitive materials from exposure. The mask on printing easels produces the white border on black-and-white prints and the panel around the film aperture in cameras masks the film around the picture.

Negative.—A photographic image in which the light subject tones are reproduced as dark, and dark subject tones are reproduced as light.

Negative lens.—A single-element lens that is thinner in the center than at the edges, or any lens that causes entering parallel rays of light to diverge. Negative lenses do not form real images, but they can be used in combination with positive lenses to form real images, where the combination will have a longer focal length than that of the positive lens alone.

Perspective (*linear*).—The representation of depth in a two-dimensional photograph by the convergence of parallel subject lines or the decrease in image size with increasing object distance. For example, train tracks converge and the distance between the two rails decreases in the photograph as the object distance increases.

Pincushion distortion.—An optical effect in which the magnification within a subject plane increases with distance from the lens axis, causing straight subject lines to be curved in the image. For example, the outside vertical edges of a building would curve away from each other at the top and bottom of the photograph. (See illustration under "Distortion.")

Positive.—A photographic image in which the tones are in approximately the same relationship as in the original, where light subject tones are reproduced as light tones and dark subject tones are reproduced as dark tones.

Positive lens.—A single-element lens that is thicker in the center than at the edges, or any lens that causes entering parallel rays of light to converge. Positive lenses can be used alone or in combination with positive or negative lenses to form real images. A combination of positive lenses will have a shorter focal length than that of any of the individual lenses.

Projection printing.—The use of an optical device containing a light source to project images of negatives or transparencies onto sensitized material for the purpose of making a print which may be larger than, smaller than, or the same size as the original. Commonly called enlarging.

Resolution target.—A design typically consisting of alternating light and dark lines that systematically vary in width, used to test the ability of one or more components of a photographic system, such as a lens, to image detail. Resolution is commonly expressed as lines per millimeter.

Retouching.—The technique of modifying a photographic image by manual methods of adding colorants, by abrading or bleaching the image, or by airbrushing. In portrait retouching of black-and-white negatives, for example, low density areas representing imperfections in the skin are darkened to match surrounding areas by adding graphite with a needle-sharp pencil.

Scratches.—Physical imperfections on a surface due to abrasion. For example, roll film can be scratched in a camera as it is advanced

or rewound due to contact with irregularities in the camera film track or pressure plate, or the light trap in the film cassette.

Sharpness.—That subjective quality of an image associated with the distinctness of boundaries between adjacent objects. Acutance is the objective measure of edge quality that is related to sharpness. For example, a variation of sharpness in photographs is associated with camera focus and depth of field.

Supplementary lens.—A positive or negative lens that is added to the lens on a camera or other optical device for the purpose of changing the focal length. A positive supplementary lens decreases the focal length and a negative supplementary lens increases the focal length. Positive supplementary lenses are sometimes referred to as closeup lenses since they enable cameras to focus on shorter object distances.

Transparency.—An image (usually positive) intended to be viewed by light that passes through the image and the base by projection or on a transparency viewer, as distinct from reflection prints which are on a more or less opaque base and are viewed by reflected light.

Wide-angle effect.—A systematic change in shape of images of three-dimensional objects with angular displacement from the lens axis (that is, from the center to the edges of the film), most noticeable in photographs made with short focal length wide-angle lenses, where images of three-dimensional objects near the edges of the field of view appear to be stretched out of shape in directions radiating away from the center of the photograph. The effect is usually not apparent in photographs made with normal focal length lenses viewed at the correct distance because images near the edges are viewed at oblique angles that compress the images in proportion to the stretching that occurred when the images were formed by the camera lens. The image of a spherical object is widened about 10 percent at 25 degrees laterally off the lens axis and about 42 percent at 45 degrees off the lens axis.

ATTACHMENT B

BRITISH BROADCASTING CORP.
Lime Grove Studios, London, February 9, 1978.

Representative RICHARDSON PREYER,
House of Representatives,
U.S. Capitol,
Washington, D.C.

DEAR CONGRESSMAN PREYER: I wanted to send this transcript along to you immediately. We initiated a detailed analysis of the Oswald holding the rifle photos by Detective Superintendent Malcolm Thompson who ran the Police Forensic Science Laboratory Identification Bureau for 25 years. He is also an ex-president of the Evidence Photographers International Council and a fellow of the Institute of Incorporated Photographers, the Royal Photographic Society and the Institute of Professional Investigators. In short, he knows what he's talking about.

As you will see, he is sure that it is a fake photo—a montage of three separate pictures. Naturally, I'll be using him in our film, but I wanted your committee to have this information directly.

I'll be returning to New York on February 20, and we'll be having a prescreening in Washington sometime thereafter. We'll be in touch with your office to work out a convenient time and place for you and any committee or staff who might be interested.

My best,

DAVID OSTERLUND.

PANORAMA KENNEDY

ROLL 1A

INTERROGATOR. Mr. Thompson would these photographs be acceptable as evidence in a British court of law?

Mr. THOMPSON. No. I have examined these photographs and have established without doubt that there is retouching on them and it is a basic principle with a forensic photographer that he would never, never retouch a photograph in any form of litigation.

INTERROGATOR. What would happen in a British court of law if photographs like this were produced as evidence in a murder case?

Mr. THOMPSON. If they were produced in a murder case then the defending counsel without doubt would have an expert examine them and if retouching was found on them then they would not be included in the evidence.

INTERROGATOR. Are you saying that if photographs like this were produced in a British court of law in a case, they would be thrown out?

Mr. THOMPSON. I do. Yes. They would be thrown out.

INTERROGATOR. What leads you to feel that?

Mr. THOMPSON. Well primarily the retouching is very very obvious in certain parts of the picture but more in particular in a perpendicular pillar here which should be a straight line. When one comes to a point, the subjects chin, one finds that there is a bulge in a line. Without doubt that shows this area between the head and the pillar has been retouched and the retoucher has just not been careful enough to maintain the retouching he should which is within the pillar in what should be a shadow area. Now that is photograph B.

In photograph A we do see the pillar as a straight pillar, it is not as if the wood has a flaw at that point there. The flaw is created in photograph B due to the fact that the retouching has extended over onto the pillar.

INTERROGATOR. I wonder if you could go through the two photographs and list for me what you regard as the discrepancies in those photographs.

Mr. THOMPSON. The backgrounds are very very similar to the point that either the camera was on a tripod when the pictures were taken or we are speaking about a common negative having been used to produce the two backgrounds. They look disimilar, there is a horizontal shift and a vertical shift in the two pictures but that purely and simply, I think, is meant to mislead the viewer.

When one measures the pictures, photograph A is enlarged slightly greater than photograph B but even allowing for that, the shadow detail in the static areas of the picture, that is in particular on the staircase here, the shadows are so exact that there is no doubt in my mind, it is either a common negative used to produce the two prints or two suc-

cessive negatives with the camera on a tripod and neither camera or tripod moved in any way between the two exposures.

There is a discrepancy up in this area here. At this point I can only assume that someone has cut out this area and changed its position slightly, it is fractional but in this picture here we see the horizontal part of the neighboring house with a highlight in this area, whereas in this picture here the horizontal part can be seen far below the section the angle caused by the upright pillar and the step. You can see a fractional difference there whereas in this picture the fractional difference does not exist.

Again with that if we take a dark triangle here between the roof of the house next door and the skyline then that d - - - angle finishes up level with the shadow of the staircase there and in the other picture the diactoral angle is below the shadow of the staircase. Similarly, the vine passing up through here is in a lower position at that point in that picture than it is in that picture.

I then come to the conclusion that part has been raised in photograph B and retouching done down here to fill up the small gap created. That is again borne out out by the fact that here in photograph A the picture finishes up dark and in photograph B at that point the picture finishes up gray.

So much for the background. If we take the body. The body shadows don't relate to the other shadows in the picture and one can only come to the conclusion that this body has been placed in the background and photographed but all the shadows here are swinging to the left whereas this shadow is slightly to the left but also behind the body is common to both pictures but when one examines the shadow content, one sees the gun at an angle to the body which does not relate to the angle in the shadow. The gun is reaching far more out to the right, more in a horizontal position here in relation to the body shadow than the gun is actually being held by the person.

INTERROGATOR. So you think that those shadows have actually been touched in.

Mr. THOMPSON. They have been touched in.

Again, there is something peculiar about this hand. The entire hand and arm is very, very unnatural. It possibly could have been stuck in afterward; but I can't relate physiologically the position of that arm to the body.

The butt of the rifle I think is the telltale in this picture here where we see very, very little of the butt actually protruding beyond the trouser line and yet down here having been painted in is a very, very large butt, I say very large in relation to the length of the shadow and we can measure the length of that shadow in relation to the height of the person and measure off the butt of the gun as against the shadow of the butt and that is to me unnatural.

The head itself, I have seen photographs of Oswald and his chin is not square. He has a rounded chin. Having said that, the subject in this picture has a square chin but again it doesn't take any stretch of the imagination to appreciate that from the upper lip to the top of the head is Oswald and one can only conclude that Oswald's head has been stuck on to a chin, not being Oswald's chin.

Then to cover up the montage, retouching has been done both to the right, that is Oswald's right and Oswald's left and when we

consider this area of retouching here—compare it with what we see in photograph A we have a shadow cast by this wooden pillar. I have measured those and even allowing for the difference and degree of enlargement between photograph A and photograph B the area we see in shadow here is far in excess of what it should be and of course that is the area to which I referred earlier on where the pillar coming down does not continue in a straight line but has this bulge in it.

INTERROGATOR. Are there other things about the face itself which would make you suspicious?

Mr. THOMPSON. Yes, again we have a shadow underneath the nose. In photographs A and B you see Oswald's face in a different posture and yet the shadow under the nose hasn't moved or if it has moved it is only fractional compared with the actual movement we see in the face and one comes to the conclusion that it is the same picture used for both faces, possibly in this face here he has got a scowl on his face and there has been retouching done in the chin area which is what would expect if my conclusion is correct, that this face has been added on to the chin.

He has a very, very thick lower lip here which is not consistent with Oswald's lip and again the shadow underneath the lip is a horizontal shadow, that is consistent in both, even allowing for the fact that we have a slight tilt in the head of photograph B as against that in photograph A.

INTERROGATOR. Is it easy to make a photo montage like this?

Mr. THOMPSON. Yes; it is very, very common in the advertising world, professional photography, advertising photographers do montages all the time because it is the easiest way of obtaining the effect they want as against trying to set up that effect, it might be an impossible effect to set up, they have got to resort to a photo montage to do it.

801 Take 1

INTERROGATOR. What about the arm?

Mr. THOMPSON. The arm in photograph B just doesn't look natural, in fact it looks as if it has been stuck on the body.

INTERROGATOR. How easy is it to make a photo montage like this, how would people go about it?

Mr. THOMPSON. It's not difficult. If one has a background scene, the subject photographed against a white background making it simpler to cut out the subject from the back.

INTERROGATOR. How do you think this photo montage was achieved?

Mr. THOMPSON. The montage could be achieved by a photograph of the background and a photograph of a body against a white background and having been cut away from that white background and then multed as we see it here and then being in possession of a photograph of Oswald's head, merely mounting that on to the top of the body, stuck down and touched in such a way that your lines are not going to be too cut and dried between the body and the background and then rephotographed on to a negative and then from that negative of course producing as many prints as you like and possibly rephotographing the print from the negative in order to soften down the background and that would develop each time the photograph was copied.

INTERROGATOR. Is that very easy to do?

Mr. THOMPSON. It is not difficult at all, don't ask me to do it, I am a forensic photographer. The last thing I would do is to retouch or indulge in any form of montage. My duty would be to present to the court what I know about the case and illustrate what I know about it in straightforward photography but there are retouchers in many facets of professional photography, they do resort to photo montages, in particular the advertising profession.

INTERROGATOR. Would the investigator agencies in America like the FBI and the CIA have that sort of professional expertise themselves?

Mr. THOMPSON. I would hope they don't have it because it is not part of their duties as forensic photographers to produce anything in court which has been retouched.

INTERROGATOR. Yes; but regardless of your hopes, I am asking whether you believe that the professional agencies in America have that sort of photographic expertise?

Mr. THOMPSON. I wouldn't think they have it but most certainly it wouldn't be difficult to get access to it. Every moderate studio in America has its retoucher in the same way as the biggest studios in Britain have their retoucher but in America you do have photographic artists, a profession all to itself, and they are spread all throughout the United States, access to one of those persons, its mostly ladies who do it and do an extremely good job in producing from a black and white picture, anything from anything as far as an oil painting from photographs.

INTERROGATOR. How quickly could you make a photographic montage like that?

Mr. THOMPSON. I would guess and say that you need at least 4 hours to produce it and that is working hard and possibly a team working at it, not just one man but I have no personal experience of how long it takes.

INTERROGATOR. Would you be prepared to produce yourself those photographs as evidence in court?

Mr. THOMPSON. After having examined them definitely not. I couldn't resort to producing anything in court which was other than just the original print from the original negative, even to the point if there was a flaw in the negative I'd be prepared to leave that in the final enlargement for the court purposes. If I was asked during the trial or the hearing then I could explain away quite simply as it being a flaw in the negative and possibly have the negative there as evidence. There is no need to retouch anything in a forensic photograph and certainly in Britain forensic photographers would just not retouch anything.

INTERROGATOR. Do you believe that those photographs are a fake?

Mr. THOMPSON. I think they are a fake and possibly the shadow detail and its relation to the static scene and the body are the give-away, plus the fact there is retouching in sufficient salient places to make one appreciate that something peculiar has gone in relation to the head and the body and the areas surrounding it.

INTERROGATOR. Can you describe what your method was in order to try and determine that it was a fake?

Mr. THOMPSON. One measures the pictures first to ascertain the degree of enlargement, there is no use comparing distances on a picture

unless you are certain that the two pictures you are comparing are of the same degree of enlargement. In this case they weren't of the same degree of enlargement and that created slight difficulty in relating one subject to another.

After having done that a very close examination of the fine detail present in the pictures brought me to my conclusion.

INTERROGATOR. Was your method to look for discrepancies?

Mr. THOMPSON. Exactly, that has been my life's work looking for the unusual and comparing one thing with another to see similarities or dissimilarities and what in general has been your conclusion in looking at those two photographs.

In general I have come to the conclusion that we have a montage of three pictures to make one end product as we see it here today.

INTERROGATOR. Does it strike you as strange that the police did not find those photographs, despite an intensive search on the day of the assassination and only found them the next day.

Well searches of premises are always difficult things, to carry out one has got to be systematic, there is only one way to carry out a proper search of a scene of crime or any other premises which might be of interest to the police and that is there are two officers doing it and one officer systematically follows round doubling what the other officer has done and in that way then two pairs of eyes should be better than one pair and nothing of importance should be missed.

So does it strike you as strange that in their search, after all connected with the assassination of a president that they should find such damning evidence the next day?

Mr. THOMPSON. It does, it does seem unusual. One would think that the officers involved would be highly experienced officers, would know and have been trained to carry out the search of premises.

INTERROGATOR. Is there any possibility in your mind that those two photographs are genuine?

Mr. THOMPSON. I don't think there is any possibility, having examined them for a considerable time it is my considered opinion that they are not genuine.

INTERROGATOR. Thank you very much.

ROLL 2A

802 Take 1

INTERROGATOR. After examining these photographs what is your professional opinion on them?

MAN. My opinion is those photographs are faked.

INTERROGATOR. What makes you think that?

MAN. The amount of retouching that is done and possibly more in particular the relationship between the shadows of the background and the shadows in the front of the body in the picture.

INTERROGATOR. Would you ever be prepared to produce those photographs in a British court of law.

MAN. No. I certainly would never contemplate using pictures which had been retouched or spotted in any way in a court of law. My task would be purely and simply to illustrate the evidence I was giving by straightforward photography. Any blemishes in my pictures then most certainly I would leave them in there and finish the enlargements

and be able to explain to the court what exactly had happened, have the negative in my pocket as a protection if necessary. There is no need to spot pictures and forensic photographers in this country will just not resort to any form of retouching of any picture.

INTERROGATOR. Is there any possibility in your view that those photographs are genuine?

MAN. There is no possibility in my view that they are genuine, they have been retouched and I consider the picture to be the result of a montage.

INTERROGATOR. Thank you.

2. AUTHENTICATION OF THE KENNEDY AUTOPSY PHOTOGRAPHS AND X-RAYS

(a) *Introduction*

(512) Authentication of the autopsy photographs allegedly taken of President Kennedy was considered essential because of the discrepant descriptions that have been given of the wounds incurred by the President. The description of the size and location of the President's head wounds, for example, by eyewitnesses at Parkland Hospital differed dramatically from the testimony of the autopsy doctors and the account set forth in the Warren Report. (*195*) More recently, the panel of medical experts convened by then-Acting Attorney General Ramsey Clark described Kennedy's head entrance wound as approximately 10 centimeters higher than the location reported by the Warren Commission. (*196*) As a result of these discrepancies, it was essential to verify that the autopsy photographs and X-rays did, in fact, depict Kennedy, and that these materials had not been altered in any way.

(b) *Issues*

(513) 1. Do the postmortem photographs and X-rays in the custody of the National Archives purporting to depict President Kennedy, in fact, depict him?

(514) 2. Is there any evidence that either President Kennedy's autopsy photographs or X-rays have been altered?

(c) *Materials examined*

(515) Twenty-seven original color transparencies and the twenty-five original black and white negatives were examined. These depicted the subject's head and upper torso from various positions.* In addition, 8″ x 10″ color and black and white photographic prints generated from these transparencies were evaluated.

(516) The X-ray materials consisted of the following items:

(517) 1. An attempted anteroposterior projection of a skull identified as:

21296 (numbers upside down).
U.S. Naval Hospital.
NNMC Bethesda, Md.
November 22, 1963.

*A more detailed description of these photographs is provided in pars. 570–571, 583–595 infra.

(518) 2. Right lateral projection of a skull with the same identification symbols.
(519) 3. Left lateral projection of a skull with the same identification symbols.
(520) 4. Three radiographs of three fragments of bone unidentified by symbols.
(521) 5. An anteroposterior projection of a chest with the same identification symbols as Nos. 1–3 above. This radiograph was obtained with the thoracic cage intact, that is, before autopsy.
(522) 6. An anteroposterior projection of a chest with the same identification as No. 5 above. This radiograph was obtained after the thorax had been opened and the lungs and mediastinal contents had been removed.

(*d*) *Procedures*

(523) Independent of the panel's analysis, the photographs and X-rays were reviewed by the three physicians who performed the autopsy, the leader of the X-ray team that took the postmortem X-rays, and by the photographer who took the autopsy pictures. These individuals indicated that the photographs and X-rays accurately portrayed Kennedy's various wounds. (*197*).
(524) The panel's board of consulting forensic anthropologists and a forensic ondontologist compared the photographs and X-rays with premortem photographs and X-rays of Kennedy. Premortem materials were studied for the purpose of discerning unique anatomic features whose presence in the postmortem photographs and X-rays would verify that the individual depicted was, in fact, Kennedy.
(525) The photographic materials and X-rays were examined visually by the panel.[1] This review included both miscroscopic examination and viewing relevant photographs in a stereoscope, a special device that allows pairs of photographs to be viewed in three dimensions. Because stereoscopy provides an excellent means by which altered or doctored photographs can be detected,[2] primary reliance was placed upon this analytical technique.[3]
(526) Finally, the autopsy X-rays, in addition to being reviewed by the panel, were analyzed for evidence of fakery by a radiologist who had particular expertise in the area of image enhancement.

(*e*) *Conclusion*

(527) 1. The postmortem photographs and X-rays in the custody of the National Archives purporting to depict Kennedy do, in fact, depict him.

---

[1] Because the Department of Defense was unable to locate the camera and lens that were used to take these photographs, the panel was unable to engage in an analysis similar to the one undertaken with the Oswald backyard pictures that was designed to determine whether a particular camera in issue had been used to take the photographs that were the subject of inquiry.

[2] The principle of stereoscopy is discussed in detail in pars. 75–79. 434–36 supra.

[3] While several of the autopsy photographs and X-days were enhanced through the use of digital image processing, the resulting enhanced photographs and X-rays were used exclusively by the autopsy panel for determining the nature and cause of wounds. They were found to be unnecessary in the analysis to detect possible fakery, since the original materials, when viewed stereoscopically, were of sufficient quality to resolve this issue.

(528) 2. There is no evidence that either the Kennedy autopsy photographs or X-rays have been altered.

(*f*) *Analysis*

(529) This section will deal primarily with the panel's visual examination. Separate reports have been filed setting forth the detailed analysis of the panel's board of consulting forensic anthropologists and the forensic odontologist.

(530) Visual inspection of the autopsy photographs and transparencies revealed no evidence of retouching, compositing, or other evidence of fakery. Because all of the relevant photographs were studied stereoscopically, it is extremely unlikely that evidence of fakery would have escaped detection.

(531) Stereoscopic viewing is made possible when two photographs of a subject are taken from a slightly different position in space (that is, a few centimeter movement of the camera or a similar degree of movement by the subject photographed). This was made possible in the present case because the autopsy photographer, in an apparent effort to insure a good final result, took two or more pictures of each relevant view.

(532) Because pairs of stereo pictures may be seen in three dimensions, such photographs add depth to the perception of the photographed scene in much the same way as a pair of human eyes, separated from one another in space, can perceive depth.

In viewing stereo pairs of photographs through a stereoscope, one eye views one picture and the other eye views the second picture. As a result, the eyes, coupled with the visual image processes of the brain, are able very readily to perceive any differences between the two pictures. Such differences in the scene between the two pictures tend literally to "pop out at you." No differences of this kind were observed by the panel in stereo pairs depicting the back of Kennedy's head, the top of his head, the large skull defect, the right front of the head, the back wound or the anterior neck wound. In this way, photographs of each of Kennedy's wounds were effectively authenticated.

(533) It is theoretically possible to alter photographs that comprise a stereo pair. To avoid detection of such alteration, however, requires that each picture comprising the pair be altered slightly different, in a systematic way. This is extremely difficult because each picture of a stereo pair is a picture of the scene from a slightly different but directly comparable, point of view. Such alteration is virtually impossible when, as in the case of Kennedy's head, the image photographed contains considerable detail.

(534) The examination of the postmortem X-rays focused primarily on the following possible indicia of fakery:

(*1*) observation of a difference in density of the images;

(*2*) discontinuity of anatomical structures;

(*3*) alteration of continuity of an abnormal pattern; or

(*4*) production of an image which is not anatomical or an image of an impossible pathologic process.

(535) No such evidence of fakery was discerned. (*198*) The X-ray images have not been altered in any fashion except for:

(536) 1. Two small areas of thermal damage resulting from a light source that was once held too close to the "anteroposterior" image. These were reported to be present on an observation report dated November 1, 1966, and validated by signature November 10, 1966. This report is in the National Archives.
(537) 2. In addition, the panel observed minor "staining" or discoloration of the images due to incomplete processing of the film in the developing process. This discoloration will continue to be more prominent with the passage of time. (*199*)
(538) Finally, the linear opacities associated with the postmortem X-rays have been said to be the result of manipulation. These opacities are normal grid lines from the grid used to eliminate "scatter fogging" of the images at the time of exposure of the films, and, therefore, represent normal images rather than evidence of manipulation.

3. FORENSIC ANTHROPOLOGICAL ISSUES

(*a*) *Introductory statement of approach*

(539) In the course of its investigation of the death of President Kennedy, the committee encountered several problems concerning the photographic identification of certain individuals either known or alleged to have been involved in the assassination. Upon the advice of other scientific consultants, it was determined that some of these problems fall within the purview of forensic anthropology, a relatively new discipline of the forensic sciences.
(540) Forensic anthropology is defined as the application of the physical anthropologist's knowledge of human variation to problems of legal medicine. As implied in this definition, forensic anthropologists, of whom there are fewer than 30 in the United States, are physical anthropologists who, by training and experience, are qualified experts in the medicolegal aspects of their science. The parent field, physical anthropology, is the study of man's biological variation in space and time. Any physical or physiological difference between human individuals and populations is of interest to physical anthropologists. Applications of their expertise range from the search and study of man's remotest fossil ancestors to helping design space suits for astronauts.
(541) For over a century physical anthropologists have measured the distances between specific anatomical landmarks of the human body in order to describe mathematically its variation in size and shape. To minimize error and insure repeatability, the measurements are made by trained anthropometrists with the subject positioned in a standardized pose. Size differences in body dimensions are reflected in the measurements themselves. Shape differences are defined by simple indices or by more complex multivariate methods. An index is ordinarily computed by dividing the smaller of two measurements by the larger and multiplying the result by 100 to eliminate the decimal. For example, the nasal index is computed as follows:

$$\text{Nasal Index} = \frac{\text{nose width}}{\text{nose length}} \times 100$$

From this, it can be seen that the nasal index provides some numerically expressed information about the shape of a given individual's nose. In a person with a short, broad nose, the index will be larger than in one whose nose is long and narrow.

(542) Although measurements are usually taken on living subjects, techniques to obtain accurate anthropometric measurements from photographs have also been developed. Nevertheless, such methods require elaborate equipment and extremely close control of the subject's pose, lighting, lens–subject distance, and other technical factors. Photogrammetric anthropometry generally also requires that the anatomical landmarks be marked on the subject in advance so that the distance between these points can be measured on the photograph.

(543) From time to time, forensic anthropologists are also asked to compare one or more photographs of crime suspects, disaster victims, or other unidentified persons to establish their identification. Usually, the photographs submitted for examination consist of casual snapshots, press photographs, studio portraits, passport pictures, or police "mug shots." Naturally, such photographs vary greatly in enlargement, camera angle, image clarity, lens-subject distance, lighting, and other factors that make direct comparison of measurements taken from such disparate photographs extremely difficult or totally impractical. For instance, an individual's nose width and length measured from a wallet-size identification photograph and a large studio portrait will be greatly different. Unless we know the exact degree of enlargement, type of camera, lens-subject distance, and many other technical features involved in making both photographs, meaningful comparison cannot be made between the nasal dimensions of the individual in terms of absolute size. Unfortunately, this kind of information is usually lacking on the types of photographs submitted for identification. In short, size differences cannot usually be studied in such analyses.

(544) Nevertheless, if two photographs are reasonably similar in camera angle—let us say, full-face—the ratio of nose width to length will be the same, or nearly so, in both photographs. Consequently, the nasal index, as defined above, can still be determined and meaningfully compared. This of course does not necessarily mean that the value of the index will be precisely the same from photograph to photograph of the same individual. Small variations in camera angle, lighting, facial expression of the subject, and measuring technique will introduce corresponding errors in the nose width and length measurements taken from the photograph, and these will be reflected as corresponding variations in the index values. Nonetheless, it is reasonable to expect the varying index values of the same individual to cluster within a reasonably narrow range.

(545) Of course, one does not rely upon a single index. Along with nasal width and length, a number of other facial measurements can be accurately taken from suitable photographs and pairs of these can be combined to produce other indices which describe other features of facial shape. Angles are also independent of enlargement factors and can be used for comparison. For example, from profile photographs one can measure the angle between the nasal bridge and the general facial plane and, in the same individual, it will be found to be fairly constant from one photograph to another. Thus, instead of only one or two indices or angles, several can be employed to add reliability to the com-

parisons. The term metric analysis is used to refer to comparisons based on numerically expressed variables such as angles and indices.
(546) The use of indices of this kind has not been refined to such an extent that a particular numerical result may automatically be considered indicative of a strong resemblance between two individuals, or that the same individual is, in fact, the subject involved in each case. Nevertheless, for general guideline purposes a mean deviation of five or less between the cumulative indices may be considered indicative of a strong physical resemblance.
(547) In addition to the analysis of metric traits by the use of such indices, there are certain other facial features which, although they cannot be conveniently measured or expressed numerically, are nevertheless very useful in photographic comparisons. This group of features vary considerably, but collectively can be called morphological (as opposed to metric) traits.
(548) An example of such a trait is the lowly ear lobe which, aside from providing a convenient place to hang earrings, seems to have no discernible purpose except to provide physical anthropologists with something to classify. Accordingly, a threefold classification of ear lobes as either free, attached, or soldered has been devised. Free lobes are those that are to some degree pendulous; in attached lobes the outside margins of the ears connect more or less directly to the side of the face. The soldered lobe is an extreme form of the attached type in which union of ear margin and cheek is so direct that there is no discernible lobe at all. Since ear lobe type can frequently be determined from photographs, the trait can be useful in identification.
(549) In addition to lobe type, there are numerous other structural features of the human ear that vary considerably from one person to the next. The total complex of these traits, while not as individually distinctive as fingerprints, are sufficiently unique to permit identification beyond reasonable doubt in many cases.
(550) Along with ears, the human face possesses an array of morphological features that, while difficult to measure, can be readily classified. The nasal tip can be elevated ("snub-nosed") or depressed, pointed or bulbous; the bridge of the nose, in profile, can be straight, convex or concave. Lips can be thick or thin; hair—straight, wavy, curly, or kinky, and so on. Also within this category are traits that are acquired by accident or age (or as Shakespeare put it ". . . through chance or nature's changing course untrimmed"). Among traits acquired during life may be included warts, moles, and other random blemishes, scars from accidents or surgery, broken noses, cauliflower ears, and other more or less permanent disfigurements. The inevitable loss of skin elasticity with age produces wrinkles and these networks of creases and furrows form patterns that uniquely characterize each human face. The comparison of traits that cannot be measured but only classified (as the ear lobe) or described as "present" or "absent" (such as a scar) constitutes the morphological analysis of the photographs in question.
(551) The forensic anthropologists serving as committee consultants were asked to deal with five specific problems of photographic identification:
(552) 1. *Authentication of JFK autopsy photographs and X-rays.*—Certain conspiracy theorists have claimed that the autopsy

photographs and X-rays are of a person other than the President. Is there scientific evidence that will support or refute this claim?

(553) 2. *The Milteer issue.*—Whether a certain man photographed in the line of motorcade spectators was actually one Joseph A. Milteer? Milteer (now dead) was a militant right wing activist who has been alleged to have had knowledge of a plot to assassinate President Kennedy.

(554) 3. *The three tramps issue.*—Shortly after the assassination, three men, described as derelicts, were apprehended by Dallas County Sheriff's officers in a boxcar on the triple overpass overlooking Dealey Plaza. These men were released without being formally identified. Could any of these men be certain individuals who some conspiracy theorists claim were involved in an assassination plot?

(555) 4. *The "Second Oswald" issue.*—Several assassination theories have been based on the speculation that Lee Harvey Oswald may, at one stage or another, have been impersonated by a double. Do the known photographs of Oswald support or refute this hypothesis?

(556) 5. *The Lovelady issue.*—Photographs taken during the assassination show a man standing in the doorway of the Texas Schoolbook Depository who bears a striking resemblance to Lee Harvey Oswald. Was this man actually Oswald or another Depository employee, Billy N. Lovelady?

(557) A review of the issues stated above shows that they were diverse in scope and therefore required an equally diverse approach in their resolution. Nevertheless, certain steps and procedures that were common to all may be briefly outlined here.

(558) 1. *Selection of materials.*—An initial step in all cases was a review of the available photographic materials and selection of those technically suitable for analysis. In some cases the selection was extremely limited. For example, because only one photograph of the spectator alleged to be Milteer was suitable for analysis, all comparisons with known photographs of Milteer had to be made against this single item. At the other extreme, dozens of photographs of Lee Harvey Oswald ranging in time from his Marine Corps enlistment to his arrest in Dallas were available for study.

(559) 2. *Measurements.*—Selected photographs were next processed for measurement. In some cases, measurements were taken from the unenlarged original photographs with a Bausch and Lomb measuring magnifier equipped with a calibrated metric scale. In others, measurements were taken from enlargements (made, when possible, from the original negatives) to the nearest 1.0 mm. All measurements were taken by one observer. Measurements reported here represent the mean of three trials.

(560) 3. *Computations.*—As noted previously, since enlargement factors were unknown, size differences—as represented by the raw measurements taken from the photographs—could not be meaningfully compared. Instead, indices were calculated between related measurement pairs. Wherever possible, landmarks, measurements and indices were selected that corresponded to those long standardized by physical anthropologists for facial anthropometry. Not all measurements could be taken from every photograph selected for study. For example, the various facial breadth measurements obviously could be obtained only from profile photographs. Even so, every effort was

made to obtain as many index measurements as possible for comparison. More detailed descriptions of data reduction and analysis will be provided in the sections dealing with the individual problems of photographic comparisons.

(*b*) *Authentication of autopsy photographs*

1. INTRODUCTION

(561) The anthropology consultants were asked by the committee to examine postmortem radiographs and photographs taken during the autopsy of President Kennedy at the U.S. Naval Hospital on Nov. 22, 1963, and, if scientifically possible, determine whether or not they were in fact those of the President. The approach to this problem was through the comparison of the postmortem X-rays and photographs with those known to have been taken prior to his death.*
(562) As noted previously in this appendix volume, the Kennedy assassination materials in the National Archives contain a series of negatives and prints of photographs allegedly taken during autopsy. The deficiencies of these photographs as scientific documentation of a forensic autopsy have been described elsewhere. (*200*) Here it is sufficient to note that:
(563) 1. They are generally of rather poor photographic quality.
(564) 2. Some, particularly close-up views, were taken in such a manner that it is nearly impossible to orient anatomically the direction of view.
(565) 3. In many, scalar references are entirely lacking, or when present, were positioned in such a manner to make it difficult or impossible to obtain accurate measurements of critical features (such as the wound in the upper back) from anatomical landmarks.
(566) 4. None of the photographs contain information identifying the victim; such as his name, the autopsy case number, and the date and place of the examination.
(567) In the main, these shortcomings bespeak of haste, inexperience and unfamiliarity with the understandably rigorous standards generally expected in photographs to be used as scientific evidence. In fact, in a criminal trial, the defense would probably raise many objections to an attempt to introduce such poorly made and documented photographs as evidence.

2. ISSUE

(568) Not all the critics of the Warren Commission have been content to point out the obvious deficiencies of the autopsy photographs as scientific evidence. Some have questioned their authenticity. These theorists suggest that the body shown in at least some of the photographs is not President Kennedy, but another decedent deliberately mutilated to simulate a pattern of wounds supportive of the Warren Commission's statements of their nature and significance. As macabre as this proposition might appear, the onus of establishing the authenticity of these photographs would have rested with the prosecution.
(569) With the above considerations in mind, the Committee requested the anthropology consultants to examine the questions sur-

*The discussion of postmortem X-rays is set forth in pars. 596–610 infra.

rounding the authenticity of the JFK autopsy photographs. Their inquiry was limited to determining the *identification* of the victim shown in the photographs. Other aspects of authentication concerning the possibility of technical alterations of the negatives and prints were undertaken by other photographic experts, as described elsewhere in this appendix. Questions concerning the description and location of the wounds and of their nature and significance, were considered exclusively by the forensic pathology consultants.

3. MATERIALS

Post mortem

(570) It has previously been recorded and the committee similarly found, that the autopsy materials in the National Archives, contain a total of 52 exposed transparencies and/or negatives.(*201*) These may be divided into two series: (1) 25 4 x 5 inch black-and-white and (2) 27 4 x 5 inch color negatives. The entire series is numbered sequentially beginning with the black-and-white series:

Black-and-white: No. 1–No. 25.

Color: No. 26–No. 52.

(571) Examination of prints of the total series revealed that most of the black-and-white negatives are virtually duplicates, in subject and view, to corresponding negatives in the color series. Consequently, our detailed analysis was limited to an examination of the color series. These items were in the form of high quality 8″ x 10″ prints specially prepared for the committee by a team of professors from RIT. Each print was identified by its original negative number. The entire series is described by subject in Table I.

Antemortem

(572) In order to compare the facial features of the autopsy subject with those of John F. Kennedy, a number of antemortem photographs of the President were examined. These were also furnished by the National Archives. Two of these (National Archives Accession Nos. 79–AR–6378G and 79–AR–8008K) were selected for a more detailed comparison since they show a full profile of the subject with his mouth slightly open, and in pose and camera angle correspond almost exactly with the full profile view of autopsy photograph No. 29.

4. CONCLUSIONS

(573) 1. The individual shown in the autopsy photographs is John F. Kennedy.

(574) 2. The brain shown in autopsy photographs No. 46–No. 52 cannot be positively identified as that of John F. Kennedy. Nevertheless, this brain displays trauma consistent with the known pattern of injury sustained by President Kennedy and, in the absence of any positive evidence to the contrary, there is no reason to believe that it is not the brain of the President.

5. ANALYSIS

(575) To examine the autopsy photographs from the standpoint of identification of the victim two hypotheses were considered:

(576) 1. That the subject shown in the photographs was not John F. Kennedy, but an unknown victim with a strong physical resemblance to the assassinated president.
(577) 2. That the victim in the photographs, in which the facial features are clearly visible, is in fact John F. Kennedy, but the body in which the face is not shown (particularly photographs No. 32 through No. 37 which document the location of the critical wounds of the back and head) is that of another, unknown, individual.
(578) In order to test the first hypothesis, it was necessary to compare the facial features of the victim in the autopsy photographs with antemortem photographs of President Kennedy. This comparison was made on the basis of both metric and morphological features.
(579) In making this comparison, it was first noted that there were no gross inconsistencies between the autopsy victim and general physical characteristics of President Kennedy. The victim is a well-nourished, dark-haired, middle-aged, white male who appears to be of northern European ethnic stock.
(580) The metric analysis was based on a comparison of autopsy photograph No. 29 with the two antemortem photographs (79-AR-6378G and 79-AR-8008K) selected from the National Archives series. The exact date of the antemortem photographs was not determined but both were made during the Kennedy presidency and therefore do not antedate the autopsy photograph by more than 3 years. All three photographs show the subject in nearly perfect facial profile; autopsy No. 29 and 79-AR-8008K are left profile and 79-AR-6378G is a right profile photograph.
(581) A series of 11 facial measurements were taken on each photograph. These measurements are defined in Table II and portrayed graphically in Figure IV-39. Measurements were recorded to the nearest 1.0 mm and made from 8″ x 10″ prints. Three sets of measurements were made on each photograph and the means were used to calculate the 10 indices given in Table III. The arrangement of President Kennedy's hair made it impossible to take physiognomic face height (mmt No. 1) in photographs 79-AR-6378G; otherwise, all the 11 measurements could be taken on each photograph.
(582) As shown in Table III, the index values of the autopsy photograph and the two antemortem photographs correspond very closely. For further comparison, the mean of the antemortem indices was compared with the postmortem values (represented by a single value in indices 1, 4, and 7 which are based on measurement No. 1 that could not be taken on 79-AR-6378G). The deviation between the antemortem and postmortem means range from 0.3 to 4.0 and the average deviation is 2.82 (Table III). This small deviation can be accounted for by a combination of several factors including that in the autopsy the subject is supine while he is standing erect in the antemortem photographs, and gravitational effects would cause some alteration of the facial features. The facial measurements would also be influenced by postmortem alterations and the effects of the massive cranial trauma. In short, the metric similarities, as expressed by facial indices are insignificant.
(583) In addition to the strong metric similarities between autopsy photograph No. 29 and the two antemortem photographs, a number of identical morphological features can be observed. The examination

of morphological similarities was not limited to the three photographs from which the measurements were taken but included comparisons between the other autopsy photographs that show the victim's face (No. 26, No. 27, No. 28, No. 29, No. 30, No. 31, No. 40, No. 41) and a series of 43 closeup photographs of President Kennedy selected from National Archives files to show his head and face from a variety of angles. In these comparisons, no inconsistencies in the morphological configuration of the eyes, nose, mouth, ears or other facial features were observed and, on the contrary, a number of identical features were apparent. These include rather distinctive traits such as the downward convexity of the nasal septum and an angular and elevated nasal tip (the latter, by the way, a trait observable in other members of the Kennedy family). Among similarities noted in the ears are a strong antihelix, small, "tucked" tragus, narrow intertragic notch and attached lobes. The lower margin of the helix is strongly concave at its junction with the lobe, giving the latter a rather attenuated appearance. Patterns of facial lines and wrinkles were similar where they could be discerned in the autopsy photographs.

(584) A partial list of morphological similarities between the autopsy subject and President Kennedy are shown in table IV. While they are simply listed in the table, each has a distinctiveness about it that impressed the examining anthropologists, both of whom have examined similar traits in a large number of human faces. Each of these traits, of course, can be separately observed in the general population. Nevertheless, the probability of their occurring together in a single individual is small. Their occurrence in two individuals with near-identical facial proportions, as expressed by the indices, is extremely remote.

(585) On the basis of the foregoing, it was concluded that the individual shown in the autopsy photographs that show the victim's face is beyond reasonable doubt, President John F. Kennedy.

(586) If it is accepted that the autopsy photographs showing the victim's face are those of John F. Kennedy, it then is necessary to examine the second hypothesis—namely that the remaining autopsy photographs are those of another person.

(587) Examination of table I shows that the entire series of 27 autopsy photographs can be grouped as follows:

Groups	*Negative Nos.*
1. Left lateral views	29, 30, 31.
2. Right lateral views	26, 27, 28, 40, 41.
3. Superior views	38, 39, 42, 43.
4. Posterior views	32, 33, 34, 35, 36, 37.
5. Cranial cavity	44, 45.
6. Brain	46, 47, 48, 49, 50, 51, 52.

(588) The photographs within each of the groups vary only slightly in camera angle, lens-subject distance, subject position, lighting and exposure. There is also sufficient commonality in morphological features and other details to leave no doubt but what they are of the same subject. Since we have concluded that photographs in groups 1 and 2 (showing the face) are those of President Kennedy, these features can be compared with features observed in the other photographs.

(589) From the standpoint of pathological interpretation, the least informative photographs are those of group 3, which provide a superior view of the head and shoulders. This is because the scalp has neither been shaved nor reflected from the cranium, procedures which would possibly have shown some of the crucial details of the cranial trauma. In these photographs, a portion of the victim's forehead and nose are shown from above. The configuration of these facial features are consistent with the nose and upper forehead contours of President Kennedy as surmised from the antemortem photographs taken from more conventional angles. Also, certain random features such as bloodstains and an apparent postmortem abrasion on the right shoulder (described in more detail below), which can be seen in the photographs of group 2, can be observed in this set of photographs. It was concluded therefore, that these photographs are of the same person as shown in groups 1 and 2 of the autopsy photographs; to wit, John F. Kennedy.
(590) The most critical set of photographs from the standpoint of identification are those of group 4 that show the head and upper back of the victim from behind. To take these photographs, the victim was apparently raised to a semi-upright position and held there while the pictures were taken from the head of the autopsy table. The purpose of these photographs was to document the scalp and upper back wounds, the exact location of which has been a matter of considerable controversy. In these photographs, the only facial features visible are the backs of the ears.
(591) In comparing these photographs with those taken in group 2, which show the right side of the head and face, several features common to both were noted. These include two dried blood stains on the upper right shoulder approximately 16 centimeters lateral to the midline of the back. Approximately 7 centimeters medial to these are a series of three narrow parallel marks approximately 3 centimeters in length, which appear to be slight skin abrasions. These marks and stains are situated several centimeters lateral to the back wound and do not appear to be directly associated with it. It is possible that they were made in the course of handling and lifting the body.
(592) There is also a 3- by 5-centimeter area of discoloration at the base of the neck in the right area that apparently represents either a slight contusion or some postmortem lividity. All of these features are very irregular in shape and would thus be very difficult if not impossible to duplicate. Such minor and random details are also the kind of characteristics that would likely be overlooked in any attempted hoax. Likewise, the hair, which is in disarray and matted with blood and body fluids, presents a complex of irregularly arranged strands and locks. Yet, allowing for the different angles of view, these features appear to be identical in size, location, and shape in both the posterior (group 4) photographs and those of the right lateral photographs of group 1, which can be identified as being of President Kennedy.
(593) In addition to the above rather transient features, others of a more permanent nature were noted. These were the network of transverse wrinkles extending across the back and side of the neck. Such lines develop in most individuals by middle age, but their exact arrangement forms a pattern that is virtually unique to the individual. Examination of these in the back photographs of group 4 shows that they are identical in pattern and development (again making allowance for view) as those seen on the lateral side of the neck in

the group 1 photographs. In short, the profusion of minute and common detail led the panel to conclude that the same individual is shown in both sets of photographs.

(594) The photographs of group 5, which show the cranial cavity with the brain removed, are somewhat more difficult to evaluate. One feature of interest is the outline of the fractured margin of the frontal bone that is partially visible in the foreground of these photographs. A deep V-shaped irregularity in this margin is also visible in photographs of group 1 in which the scalp is partially reflected to expose the underlying bone. The anterior margin of the cranial defects also corresponds in shape to the fractures observed in the cranial X-rays.

(595) From the standpoint of positive identification, the most problematical group of autopsy photographs are those of group 6 which show the isolated brain. Here the panel could find no anatomical features that would associate this brain with the remaining autopsy photographs. Nevertheless, the trauma to the brain, affecting primarily the superior aspect of the frontal lobes is certainly consistent with the pattern of cranial trauma observed in the X-rays and other autopsy photographs.

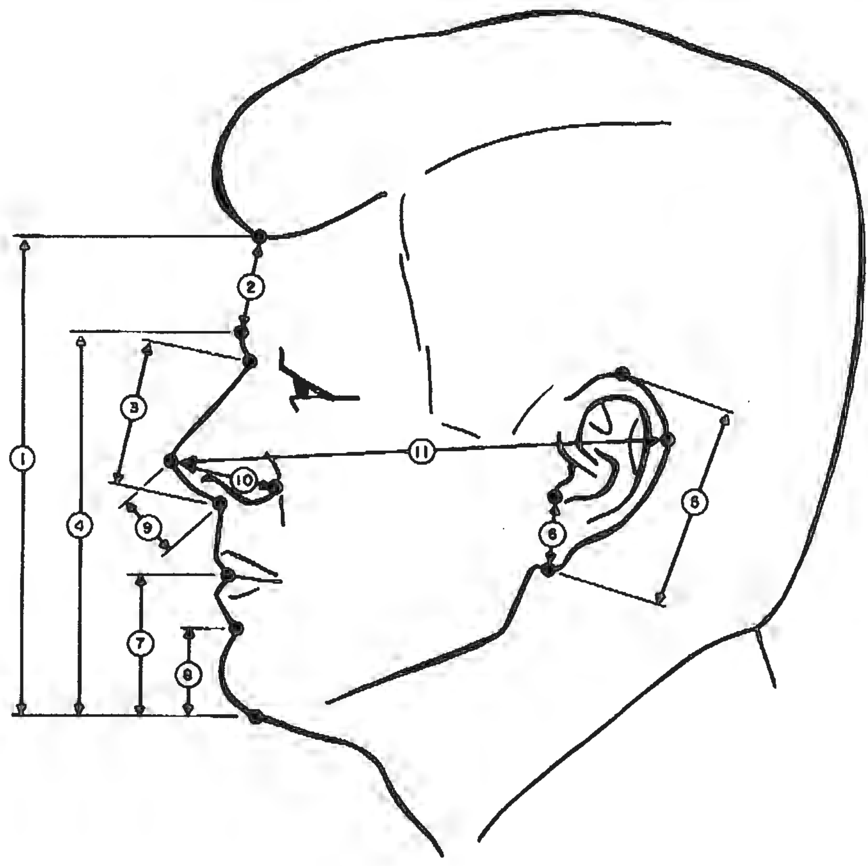


FIGURE IV–39.—Diagram of Measurements Set Forth in Table I.

Table I.—*Description of autopsy photographs examined in authentication study*

Number		
26	Head, right lateral	Superio-lateral view of head in quarter profile. Includes anterior neck wound, upper chest and shoulders.
27	Head, right lateral	
28	Head, right lateral	
29	Head, left lateral	Profile view. Includes anterior neck wound. No. 30 overexposed.
30	Head, left lateral	
31	Head, left lateral	
32	Head, superior	Superior view of head and shoulders.
33	Head, superior	
34	Head, superior	
35	Head, superior	
36	Head, superior	
37	Head, superior	
38	Upper torso, posterior	Shows shoulder wound.
39	Upper torso, posterior	
40	Head, right lateral	Inferio-lateral view of head in quarter profile. Includes anterior neck wound.
41	Head, right lateral	
42	Head, posterior	Close-up of occipito-parietal area showing scalp wound.
43	Head, posterior	
44	Cranial cavity	Anterio-superior views of cranial cavity. Brain removed.
45	Cranial cavity	
46	Brain, inferior	Removed from cranial cavity.
47	Brain, inferior	
48	Brain, inferior	
49	Brain, inferior	
50	Brain, superior	
51	Brain, superior	
52	Brain, superior	

Table II.—*Measurements used to derive indices for comparison of JFK antemortem photographs with autopsy photographs No. 29*

1. Physiognomic face height—Distance from the midpoint of the hairline to the lowest point on the chin (*trichion* to *menton*).
2. Forehead height—Distance from the midpoint of the hairline to the most anterior point on the lower forehead just above the nasal root depression (*trichion* to *glabella*).
3. Nose length—Distance from the deepest point of the nasal root depression to the junction point between the nasal septum and the upper lip (*subnasion* to *subnasale*).
4. Total face height—Distance between the most anterior point on the lower forehead just above the nasal root depression and the lowest point on the chin (*glabella* to *menton*).
5. Ear length—Distance between the uppermost point on the helix of the ear and the lowermost point on the earlope (*superaurale* to *subaurale*).
6. Lobe length—Distance between the lowest point in the intertragic notch and the lowest point of the earlobe (*intertragion* to *subaurale*).
7. Mouth height—Distance from the point of contact between the upper and lower lip and the lowest point on the chin (*stomion* to *menton*).
8. Chin eminence height—Distance from the point of deepest depression between the lower lip and chin and the lowest point on the chin (*supramentale* to *menton*).

9. Nasal projection---------Distance from the most anterior point on the nasal tip to the junction point between the nasal septum and the upper lip (*pronasale* to *subnasale*).
10. Nasal elevation----------Distance from the most anterior point on the tip of the nose to the posterior most point on the junction line between the nasal alae and the cheek (*pronasale* to *postalare*).
11. Total facial depth---------Distance between the most anterior point on the nasal tip and the posterior most point on the posterior margin of the helix of the ear (*pronasale* to *postaurale*).

TABLE III.—COMPARISON OF FACIAL INDEX VALUES OF ANTEMORTEM PHOTOGRAPHS OF PRESIDENT JOHN F. KENNEDY (79-AR-6378G, 79-AR-800K) WITH LEFT PROFILE PHOTOGRAPH (NO. 29) OF AUTOPSY SUBJECT

Index (M/M×100) [1]	Antemortem			Postmortem (No. 29)	Δ [2]
	79-AR-6378G	79-AR-8008K	Mean		
1. 2/1×100		27.0	27.0	30.7	3.7
2. 3/4×100	26.4	35.1	35.8	33.1	2.7
3. 8/4×100	21.4	21.1	21.2	18.1	3.1
4. 7/1×100		28.4	28.4	2[illegible].6	2.8
5. 7/4×100	37.1	36.8	37.0	33.8	3.2
6. 6/5×100	29.4	33.9	31.6	33.9	2.3
7. 5/1×100		41.2	41.2	37.5	3.7
8. 9/3×100	47.1	45.0	46.0	50.0	4.0
9. 10/3×100	60.8	61.5	61.2	63.6	2.4
10. 5/11×100	49.7	45.9	47.8	47.5	.3

[1] Numbers refer to measurements defined in table II.
[2] Absolute differences between mean of antemortem index and postmortem index.

Note: Mean deviation equals 2.82.

TABLE IV.—*Morphological similarities in both the ante mortem and post mortem Kennedy photographs*

Convex angle of nasal septum.	"Tucked" ear tragus.
Lower third of nose convexity.	Distinctive lip profile.
Nasal tip area elevated.	Identical facial crease lines.
Attached ear lobe.	Similar neck crease lines.
Strong ear antihelix.	

(c) *Authentication of Autopsy X-rays*

1. INTRODUCTION

(596) Human bone structure varies uniquely from one individual to another. The bones not only differ in their overall size and shape but also in their minute structural details so that the total pattern of skeletal architecture of a given person is as unique as his or her fingerprints. Forensic anthropologists have long made use of this fact in establishing the positive identification of persons killed in combat, aircraft accidents, or other disasters, by comparing X-rays taken before death with those of the unidentified body taken after death.
(597) Of course, just as no two individuals are alike, no two X-rays of the same bones of the same person are ever exactly alike because there is always some variation in the positioning of the subject, the X-ray technique, and the processing of the film. The skeleton also undergoes some remodeling throughout life so that a certain amount of variation in detail is to be expected in films of the same individual taken a few years apart. Nevertheless, with experience, these technical and age variations can be taken into account so that, given a pair of reasonably good films of the same person, posed in the same way, a

positive identification can nearly always be made even if the X-rays were made many years apart by different technicians using different equipment.

(598) In the following analysis the committee applied this method in comparing the post mortem X-rays said to be those of President Kennedy with clinical films known to have been taken prior to his death.

2. ISSUE

(599) Just as they have questioned the autopsy photographs, critics of the Warren Commission have suggested that the autopsy X-rays are not those of President Kennedy. The committee asked the anthropology consultants to examine the X-rays to determine if they are of the President.

3. MATERIALS

(600) Both ante mortem and post mortem X-rays examined were from the JFK assassination materials curated by the National Archives.

(601) The autopsy X-rays bear the case number "21296" of the U.S. Naval Hospital in Bethesda, Md. They include front and side views of the skull as well as a series of overlapping views of the torso and upper legs. There are also several X-rays of three skull fragments reportedly found in the Presidential automobile after the assassination.*

(602) In addition to the autopsy X-rays, the Archives collection includes three sets of clinical X-rays of President Kennedy taken at various times prior to his death. Two of these sets were made by personal physicians who treated the then-Senator Kennedy for an upper respiratory illness in August 1960. The earliest, dated August 14, bears the case number "202617" of Dr. Stephen White, 521 Park Avenue, New York. The second set was made 3 days later at the clinic of Drs. Groover, Christie, and Merritt of 1835 I Street NW., Washington, D.C., and bears the case number "336042." Dr. White's series consists of a side view of the head and a routine chest plate. Those from the Groover, Christie, and Merritt Clinic include side and front views of the skull. The third set of ante mortem X-rays were taken at the U.S. Naval Hospital in Bethesda on March 14, 1962, while President Kennedy was undergoing treatment for a back complaint. These X-rays consist of front and side views of the lower spine and pelvis. Hereafter, these three sets of ante mortem X-rays will be referred to as the "White," "Groover," and "Navy" films, respectively.

4. CONCLUSION

(603) Both the skull and torso autopsy radiographs, now in the possession of the National Archives, are X-rays of President John F. Kennedy.

5. ANALYSIS

(604) First the "Groover" and "White" ante mortem X-rays of the skull were compared with the autopsy films. In the front views, it was found that the outlines of the frontal sinuses of the autopsy X-rays

---

*A list of these materials is set forth at pars. 516–522 *supra*.

were virtually superimposable on those shown in the clinical X-rays. The sinuses, which are lobular air pockets inside the bone that forms the forehead, vary uniquely in size and shape from one person to another. This variability is seen particularly in the outlines of their upper margin which typically cast a set of scalloplike shadows on the X-ray. This scallop pattern is so individually distinctive that forensic anthropologists have termed them "sinus prints." For many years, courts of law throughout the world have accepted the matching on ante mortem and post mortem X-rays of the sinuses as evidence for the positive identification of unknown bodies. In the present case, the similarity in shape of the sinus print patterns in the ante mortem and post mortem films is sufficient to establish that they are of the same person on the basis of this trait alone.

(605) In addition to the sinus prints, several other strikingly similar anatomical features were observed in the front view X-rays. For example, the nasal septum—the thin wall of cartilage and bone that separates the nostrils—was deviated to the same side and to an identical degree in ante mortem and post mortem films. Also, the outlines of the bony rims of the orbits of the eyes were nearly identical. The very slight variations observed in these three features—sinus pattern, nasal septum, and orbital margins—are the results of minor differences in the way the X-rays were taken.

(606) The profile views of the skull in the White and Groover films were next compared to the autopsy X-rays. Again, a number of almost identical anatomical features were observed in the ante mortem and post mortem films. For example, the outlines of the *sella turcica* (the saddle-shaped depression in the base of the skull), the complex patterns of the cranial sutures (the joints uniting the bones of the skull), and location and arrangement of the vascular grooves (the shallow depressions on the inner surface of the skull which mark the course of blood vessels) were the same. There was also nearly exact duplication of the honeycomblike air cells of the mastoid bone.

(607) The chest X-ray taken by Dr. White in 1960, was next compared to those of the upper torso taken at autopsy. Again, a number of identical features were noted in both sets of films. Among these were the outlines of the dorsal spines of the thoracic vertebrae. (These spines are the bony projections that are visible just under the skin along the center of the back.) In X-rays these spines project a vertical series of small shadows of varying sizes and shape that, like the architectural features of the skull discussed above, are virtually unique in each individual. In shape these shadows may range from almost perfect circles to irregular trapezoids. They vary not only from one individual to the next but from one vertebra to another in the same individual so that the series of a dozen or so of these spines, usually visible in a standard chest film, form a combination of shapes distinctive for each individual. Allowing for slight distortions due to position and technique, this series of spines can be considered identical in the antemortem and postmortem films.

(608) In addition to the similar pattern of dorsal vertebrae spines, a number of other features common to both sets of film were observed. For example, the size and shape of the medial ends of the clavicula (collar bones) were identical, as was the pattern of ossification of the costo-chondral junctions of the first ribs. Numerous details in the form

and trabecular structure of the ribs could also be matched from one set of films to the other, particularly in the left eighth and ninth ribs which were especially well-defined in both films.

(609) The autopsy radiographs of the lower torso, including the pelvis and upper legs, could be compared to the antemortem Navy films taken in 1962. These also show an impressive number of osseous details in common. Of particular interest was the right transverse process of the fifth lumbar vertebra. In both sets of films it was displaced upwards in a manner suggestive of a congenital malformation or an old, ununited fracture.

(610) To summarize, the skull and torso radiographs taken at autopsy match the available ante mortem films of the President in such a wealth of intricate morphological detail that there can be no reasonable doubt that they are in fact X-rays of John F. Kennedy, and no other person.

(d) Comparison of photographs of Joseph Milteer with that of an unidentified Dallas motorcade spectator

1. INTRODUCTION

(611) An unidentified motorcade spectator who bears a strong resemblance to Joseph Adams Milteer, a militant right-wing organizer who is alleged to have been a possible coconspirator in the assassination, appears in the background of a photograph that was taken by Associated Press photographer James W. Altgens less than a minute before the assassination occurred. *(202)* The presidential limousine can be seen passing the Dal-Tex building on Houston Street just before the vehicle turned south onto Elm Street in front of the Texas School Book Depository Building. The spectator in question is seen standing on the east side of Houston Street, just beyond the limousine. He is a white male appearing to be about 60 ±10 years of age. Immediately to his right is a taller man wearing a dark hat, coat and necktie. (See figure IV–40, JFK Exhibit F–124).

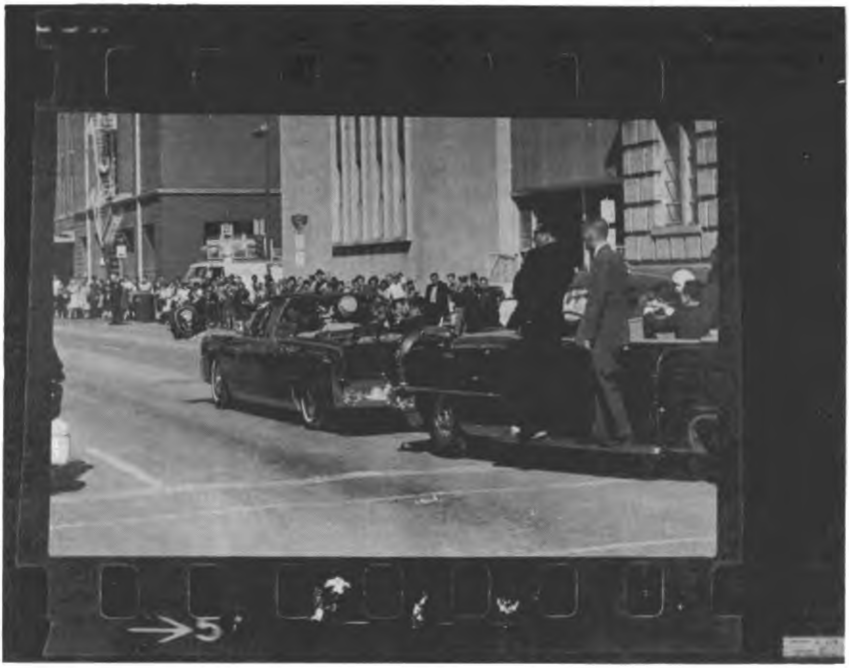


FIGURE IV-40.—Altgens 1-5 photograph taken on Houston Street.

(612) Milteer's possible involvement in the assassination was first brought to public attention by Harold Weisberg, the author, who described a taped conversation that allegedly took place in Miami, Fla. 13 days before the assassination between Milteer and a Miami police informant, Willie A. Somersett (both now deceased).(*203*) During the taped discussion, a voice identified as that of Joseph Milteer says that a plan to kill the President is "in the working" and describes how the President could be shot "(f)rom an office building with a high-powered rifle."(*204*) FBI documents describe subsequent interviews, both with a "reliable informant," (*205*) relating further incriminating comments by Milteer regarding the events of the assassination, (*206*) and with Milteer, who denied any involvement.(*207*) These FBI documents were retained in the Warren Commission files, but the Commission is said not to have investigated this matter further.(*208*)

(613) Assassination critics raise the possibility that Milteer was an active participant in a conspiracy and present in Dealey Plaza at the time of the assassination as evidenced by the Altgens photograph. (*209*) The man the critics claim is Milteer also appears in a few frames of the Bell, Nix and Muchmore motion picture films.

2. ISSUE

(614) By comparing known photographs of Milteer with photographs of the motorcade spectator in Dealey Plaza, is it possible to determine whether the spectator, in fact, is Milteer?

3. MATERIALS

(615) (*a*) The photographs of Joseph Milteer consist of the following items:

FIGURE IV–41.—Undated studio photographs of Joseph Milteer.

Figure IV–41.—Two undated 5 x 7-inch black-and-white studio portraits stamped "Modern Studio, 219 W. Adams Street, Jacksonville, Florida." In these, the subject appears to be about 40 ±5 years old. As Milteer was born in 1902, these photographs probably date from the 1940's or early 1950's.

Figure IV–42.—A 3 x 3-inch snapshot of Milteer seated in a chair. A 1957 calendar appears in the background.

Figure IV–43.—A 3 x 4-inch black-and-white photograph. This photograph is undated, but judging from the subject's apparent age is obviously later than Figure IV–41 photographs and probably also later than figure IV–42.

Figure IV–44.—A 3.5 x 5.5-inch black-and-white photograph of Milteer standing beside an unidentified elderly woman. It is undated, but is said to have been taken in the early 1970's when Milteer was about 70 years old.

FIGURE IV-42.—Color snapshot of Joseph Milteer. Note 1957 calendar in background.

FIGURE IV–43.—Undated photograph of Joseph Milteer.

FIGURE IV–44.—Photograph of Joseph Milteer taken in early 1970's.

(616) (*b*) Prints of the spectators were made from the original Altgens negative. (See fig. IV–45, JFK Exhibit F–563). In addition both the Altgens negative and relevant frames of the Bell film were subjected to digital image processing. (*210*)* (See fig. IV–46).

4. CONCLUSIONS

(617) Milteer resembles the Kennedy motorcade spectator in age and general facial configuration. The spectator appears to have worn eyeglasses similar in general style to those favored by Milteer. The spectator, however, does not resemble Milteer in upper lip thickness; he is also partially bald, whereas Milteer apparently had a full head of hair in the photograph that was taken several years after the assassination. (See fig. IV–44). Most significantly, Milteer's reported stature of

* Computer enhancement of the spectator as seen in the Bell film did not produce usable results.

64 inches places him about 6 inches under the spectator's estimated stature.*

(618) In the absence of evidence that (1) Milteer had become extensively bald by 1963 or was wearing a hairpiece in the postassassination photograph, or that (2) Milteer's statural estimate of 64 inches is incorrect, the motorcade spectator could not have been Joseph Milteer.

5. ANALYSIS

First. Metric analysis

(619) Although several enlargements and an enhanced photograph of the spectator have been furnished for examination, they are not sufficiently sharp to permit any meaningful comparison based on facial measurements and indices. (See fig. IV–46).

Second. Age

(620) The age of the motorcade spectator is estimated at 60 ±10 years. Milteer was approximately 61 years old in 1963.(*211*)

Third. Eyeglasses

(621) In all three photographs of Milteer taken during his later years he is wearing eyeglasses with composite frames (plastic upper rims, wire lower) and a broad metal nosepiece. (See figs. IV–42 and IV–44). The spectator is also wearing spectacles which appear to be of the same general style favored by Milteer. (See fig. IV–46.)

Fourth. Lip thickness

(622) All of the available Milteer photographs show that the membranous position of Milteer's upper lip was very thin. The enhanced photographs of the spectator suggest a rather full and thick upper lip. (See fig. IV–46). This is not a trait apt to be influenced by normal variation in facial expression.

Fifth. Hair

(623) In the earliest photographs Milteer has a full, regular hairline with no central or lateral retreat suggestive of incipient baldness. (See figure IV–41). In the photograph that was apparently taken when Milteer was about 55 years old, his hairline is virtually identical to that of the earlier photographs. (See figure IV–42). The latest photograph, taken about a decade after the assassination, shows Milteer with a full head of hair. (See figure IV–44). The spectator, however, appears to have little, if any, hair. The extent of his balding, though, could not be ascertained; no hairline is visible, and in fact, the entire frontal crown of his head appears bare. (See figure IV–46).

Stature

(624) The only available height record on Milteer gives his stature as 64 inches.(*212*) This corresponds to about the seventh statural percentile of American males. That is, about 93 out of 100 adult American men would be taller than Milteer. Also, about 35 percent of adult American females would exceed Milteer's reported height.(*213*) In contrast, the spectator alleged to be Milteer is taller than 4 of the 7 other males and all of the 16 females in the line of spectators shown in the motorcade photograph. Based upon Milteer's reported height, the

---

*See infra, pars. 625–659.

probability of randomly selecting a group of Americans where so many are shorter than Milteer's reported height is .0000007. Moreover, an analysis based upon actual measurements of certain physical features shown in the photograph yields a height estimate for the spectator of about 70 inches—6 inches taller than Milteer's reported stature.*

ADDENDUM

HEIGHT ANALYSIS OF ALLEGED JOSEPH MILTEER

(625) According to the only known physical description of Milteer, he was 64 inches (162.6 cm) in height. (*214*) As errors of as much as ±2 inches are not uncommon in police and medical records, (*215*) we will assume that his true stature was somewhere between 62 and 66 inches (157.5–167.6 cm). The key question, then, is whether or not the stature of the motorcade spectator falls within the estimated stature range of Milteer. If so, the finding would not, of course, prove that the spectator was indeed Milteer but would at least be consistent with this theory. If, however, the spectator's stature falls outside the range, it would substantially decrease the likelihood that he is Milteer.

Materials and methods

(626) The photograph on which the following analysis was based was taken from the intersection of Main and Houston shortly after the presidential limousine had turned right onto Houston Street from Main. (See figure IV–40). The view takes in the entire front of the Dallas County Records Building and a portion of the Dal-Tex Building. Direction of view is toward the northeast.

(627) In this photograph, the spectator in question is a balding white male in a light-colored short-sleeve shirt who appears to be about 60 ±10 years of age. He is standing in the line of spectators arrayed along the sidewalk in front of the records building. Immediately to his right is a tall white male in a dark suit and hat.

(628) For the analysis, the committee furnished the original 35 millimeter black-and-white negative taken by James Altgens. Our photographic measurements were made from an 8 x 10 inch enlargement of the negative. See figure IV–45. Angular measurements were recorded to the nearest 0.10 and taken with a Lutz–10 inch protractor. Linear measurements were taken with a needlepoint Helios dial caliper to the nearest 0.1 millimeter. Each angular and linear measurement reported here represents the mean of three trials.

The site

(629) A map of the site (Warren Commission exhibit 882, 17:901) shows the sidewalk fronting the records building to be of uniform width (10 feet) from the Houston-Elm corner southward to where it curves into the driveway between the records building and the Criminal Courts Building. From measurements by the committee (*216*) the elevation of the sidewalk in relation to the records building was found to be uniform. The street, however, slopes slightly upward so that the curb is higher near the driveway entrance than at the Houston-Elm corner.

***A detailed analysis of the available statural data is given infra, pars. 625–659.**

Signposts

(630) Physical features of particular importance in the following analysis are the two tall street signposts located a short distance north of the spectator alleged to be Milteer. (See fig. IV-45). Each post holds three vertically arranged signs, the lowest of which bears the notice "no parking except police officers." According to information supplied by the committee, the standard dimensions for such signs in Dallas are 12 x 18 inches and, in 1963, city regulations specified that the bottom edge of the lowest sign be set 80 inches above the sidewalk. (*217*)

Vertical and horizontal reference lines of motorcade photograph*

(631) The vertical reference line (VRL) of the motorcade photograph is taken as coincident with the northwest corner of the Dallas County Records Building.

The horizontal reference line (HRL) which represents the elevation of the center of the camera lens, can be calculated from the perspective angles of two transverse masonry seams that run across the west face of the records building. (See fig. IV-45). The upper of these seams passes along the bottom edge of a large window. The lower line is partially obscured by the heads of the spectators. The upper line slopes upward, and the lower line slopes slightly downward from left to right; therefore, the HRL must pass between them and also perpendicular to the VRL.

(632) The law of perspective dictates that the two masonry lines, if extended indefinitely, would meet at the vanishing point of the photograph.** Consequently, their extensions may be visualized as forming the sides of a triangle, ABC, the apex of which is the vanishing point and the base of which is that segment of the VRL subtended by the angle of convergence of the masonry lines. Since, as noted above, the HRL must pass between the masonry lines and is also perpendicular to VRL, it can be visualized as subdividing the triangle ABC into two smaller right triangles AHC and HBC (See figure IV-47).

(633) The angles α and α', measured from the photograph are 89.0° and 87.5°, respectively, and

$$\beta=90.0-89.0=1.0^\circ$$
$$\beta'=90.0-87.5=2.5^\circ$$

and since

$$\frac{AH}{AB}=\frac{AH}{AH+AB}=\frac{\tan\beta}{\tan\beta+\tan\beta'}=\frac{\tan 1.0^\circ}{\tan 1.0^\circ+\tan 2.5^\circ}=.286$$

the distance of HRL above the intersection of the lowest masonry line with VRL is about 28.6% (=.286×100) of the total distance between the masonry lines. When projected onto the photograph, the HRL is seen to pass slightly above the head of the alleged Milteer. (See Figure IV-47).

---

*Measurements are made above and below a hypothetical plane known as the datum plane or horizontal reference line, analogus to measurements that a geographer reports relative to sea level. Vertical distances are measured along or parallel to a vertical reference line that runs perpendicular to the horizontal reference line.

**For a discussion of the "vanishing point" concept see pars. 414-417 *supra*.

FIGURE IV-45.—Enlargement of original Altgens photograph used in stature analysis of spectator alleged to be Joseph Milteer.

Enhancement by digital image processing

FIGURE IV–46.—Enlarged enhancements of spectator from Altgens photograph.

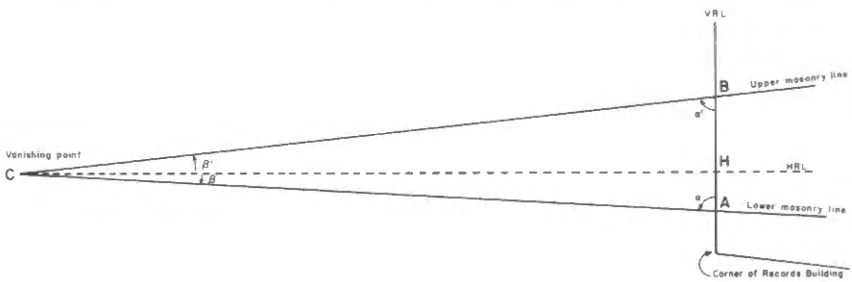


FIGURE IV–47.—Derivation of the vanishing point (C) and the horizontal reference line (HRL) from the Altgens photograph, using masonry lines and the northwest corner of the Dallas County Records Building as the vertical reference line (VRL).

The spectators

(634) Approximately 60 spectators are shown in the motorcade photograph. (See figure IV–40). They are standing in an irregular line stretching from the south end of the Records Building northwards to the vicinity of the southwest corner of the Dal-Tex Building. At the south end of this line are five males, four of whom are standing in the street in front of an automobile parked near the driveway entrance. The fifth man of this group is sitting on the fender of the automobile. At the north end of the line, extending from the southeast corner of the sidewalk of the Houston-Elm intersection, most of the spectators are also standing in the street.

(635) Between these two groups, is an intermediate segment of the spectator line consisting of 28 individuals, including the alleged Milteer. (See figure IV–45). In the motorcade photograph, the lower bodies of these spectators are obscured by the presidential limousine so that it is impossible to determine whether they are standing in the street or on the curb. Nevertheless, other motorcade films show that the individuals in the north portion of this line, including the spectator under investigation, are standing along the edge of the sidewalk. (*218*) Judging from their relative height and position, it seems reasonable to assume that the persons in the south end of this line are also on the sidewalk. At the south end of this line is a white female shading her eyes with a parcel held in her left hand; the line ends with a Black man wearing a dark hat who is standing just to the left of the utility pole at the northwest corner of the Records Building.

(636) Besides the alleged Milteer, this group of sidewalk spectators consists of 27 individuals. The sex of two cannot be determined as they are nearly totally obscured by other spectators. Among the remaining 25 are 17 women and 8 men. Two of these spectators, a male in a non-military uniform, and a very short female standing immediately on the left of the man alleged to be Milteer, appear to be rather young individuals who may not have attained adult stature. The remaining 7 males and 16 females are adults ranging from about 20 to 60 years of age. Two of the males and six of the females are Black. Judging from their short stature and rather dark complexions, it is possible that as many as 4 of the 10 Caucasoid females may be of Mexican-American ethnic extraction.

(637) Thus, in terms of age and ethnic composition, the group seems fairly representative of the urban population of Dallas during the 1960's. (*219*) The preponderance of females might be accounted for by the relatively large number of women employees in the many retail stores, business offices and local government agencies in this area of downtown Dallas. Barring undue sampling errors, the average stature of both sexes in the group might be expected to approximate the mean stature of the general U.S. adult population.

Methods of analysis

(638) The hypothesis that the spectator's stature falls within Milteer's stature range of 64 ±2 inches can be tested by two methods:

(639) 1. Estimation of the spectator's height in relation to the street signs; and

(640) 2. Relating his height to the heights of the other sidewalk spectators.

(641) Although possibly redundant, using both methods is advantageous as they are independent; that is, neither relies on information used in the other. More specifically, the first method could be used even if the alleged Milteer were standing alone on the sidewalk and, conversely, the second method does not depend on the presence of the street signs in the photograph. As each method is based upon different assumptions and subject to different errors, they provide a valuable check upon one another.

(642) Both methods share the assumption that the elevation of the sidewalk, from north to south, is uniform. Beyond this, each method has a unique assumption:

(643) *Method 1.*—The signpost dimensions provided the Committee by Dallas Street Department officials are correct. This must be assumed because the actual signs seen in the 1963 photograph have been removed and, thus, can no longer be measured directly.

(644) *Method 2.*—In using this method it is assumed that, as a group, the stature of the adult men and women standing along the sidewalk approximate the statural norms of the general U.S. population of the 1960's.

Test 1: Estimation of height from street signs

(645) If the spectator happened to have been standing against one of the signposts, it could be used as a simple measuring rod to obtain a measurement of his stature. Unfortunately, this is not so; therefore this would violate the geometric rules of perspective by simply passing a horizontal line across the top of the spectator's head and using its intersection with one of the signposts as the measuring point.

(646) Imagine, however, that there was a third sign, identical to the other two, positioned immediately behind the spectator. Such a sign would provide an ideal measuring rod as the spectator is standing by the edge of the sidewalk.

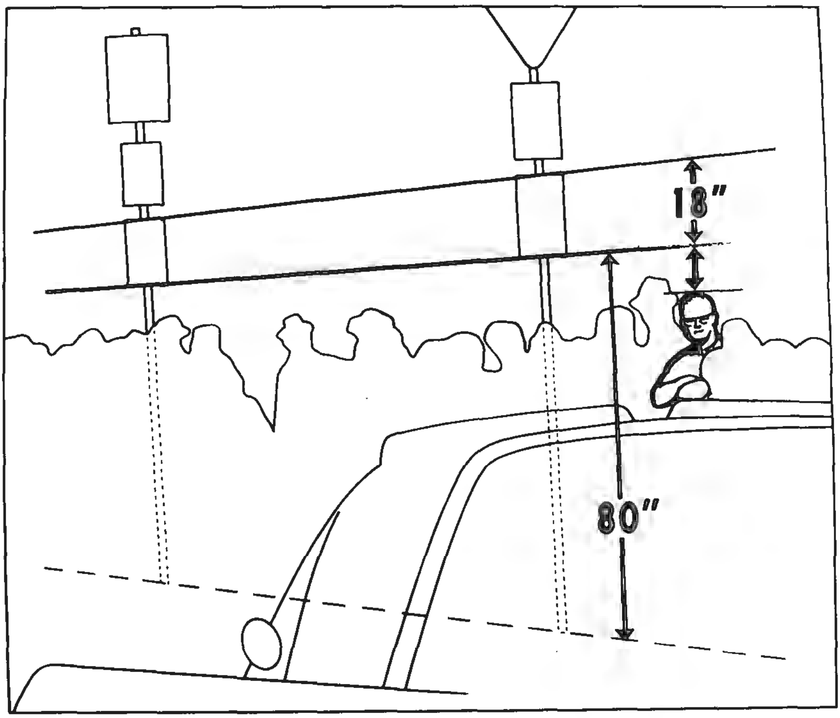


FIGURE IV–48.—Estimation of spectator's height from street signs.

(647) Taking the laws of perspective into account, this imaginary sign can be constructed by passing two lines connecting the tops and bottoms of the real signs to a point immediately above the top of the spectator's head. A vertical line, perpendicular to HRL, passing upward from the top of the spectator's head represents the post of the imaginary sign. (See figure IV–48, JFK exhibit F–562.) This sign will have the same actual dimensions of the other two: its length is 18 inches and its lower border is 80 inches above the sidewalk. From these relationships the spectator's stature can be calculated from the formula: Stature, inches $= H - \frac{sd}{s'}$ where

H = height of lower border of sign above sidewalk in inches
s = actual length of sign in inches
s' = length of sign measured on photograph in millimeters
d = distance from top of spectator's head to lower border of sign measured on photograph in millimeters

(648) In the present case, $H = 80$ inches, $s = 18$ inches, $s' = 16.1$ mm and $d = 9.1$ mm, so

$$\begin{aligned} \text{spectator's stature} &= 80 - \frac{(18 \times 9.1)}{16.1} \text{ inches} \\ &= 80 - 10.2 \text{ inches} \\ &= 69.8 \text{ inches} \end{aligned}$$

(649) In round figures, the stature of the alleged Milteer would have been about 70 inches (177.8 cm) or 5 foot, 10 inches. Thus, he would have been about 2.5 inches taller than the average 55–64 year old U.S. male of the early 1960s. *(220)* More importantly, he exceeds Joseph Milteer's reported stature of 64 inches by 6 inches.

Test 2: Stature relative to other spectators

(650) Just as an imaginary sign has been created, it may be imagined that the two real signs have vanished. Now there is no convenient measuring rod against which the spectator's stature may be measured. Nevertheless, inspection of the photograph shows that, among the adult spectators lining the sidewalk, only one, the man in the Black hat standing next to him, is clearly taller than the alleged Milteer. (See figure IV–49, JFK exhibit F–563). Allowing for perspective, it is possible that the two Black males toward the end of the line are also taller; if it is assumed they are, then four of the seven males can be counted as shorter than the spectator. He is also definitely taller than all of the 16 adult females among the sidewalk spectators.

FIGURE IV–49.—Spectator's stature relative to other bystanders.

(651) Consider then the null hypothesis that the spectator is actually only 64 inches in height. If so, he has managed to insert himself among an apparently random group of 23 adults of whom 7 men and 16 women are shorter than he. Such an elfin array would be unlikely to congregate through chance alone in downtown Dallas, Tex.

(652) According to a nationwide anthropometric survey of adult Americans conducted in 1960–62, the median height of males was 68.3 inches (173.5 cm) and of females 62.9 inches (159.8 cm). Furthermore, only about 7 percent of men were under 64 inches in height. Approximately 65 percent of adult females were shorter than 64 inches. *(221)* Stated differently, if the spectator's stature was only 64 inches, he would be shorter than about 93 percent of adult men and 35 percent of adult women.

(653) As adult stature is normally distributed, the probability of randomly selecting a group of 16 adult women shorter than 64 inches from the general population is as follows:

$$P\,♀_{16 \leq 64''} = C_{16,\,16}\,(.65)^{16}$$
$$= .00102 \text{ or about 1 in 1000.}$$

(654) The probability of randomly selecting a group of seven American men, four of whom are less than 64 inches in height is as follows:

$$P\,♂_{4 \leq 64'' \leq 7} = C_{7,\,4}(.07)^4\,(.93)^3 + C_{7,\,5}\,(.07)^5\,(.93)^2 + C_{7,\,6}\,(.07)^6\,(.93) + C_{7,\,7}\,(07)^7$$
$$= .00075, \text{ or about 75 in 100,000.}$$

(655) Since $P\male$ and $P\female$ are independent, the probability of randomly selecting a group of sixteen females and seven males with the above-defined statural characteristics is even smaller:

$$
\begin{aligned}
P\male\female &= (P\male)\ (P\female) \\
P\male\female &= (.00102)\ (.00075) \\
P\male\female &= .0000007
\end{aligned}
$$

In other words, the odds are less than a million to one that the spectator is as short as 64 inches—Joseph Milteer's reported stature.

(656) For the sake of argument, it may be assumed that the 64-inch stature record of Milteer understates his true height by two inches, making him 66 inches tall. According to the survey cited above, about 85 percent of women and 20 percent of men are less than 66 inches in stature. Using the same approach detailed above, the probability is as follows:

$$
\begin{aligned}
P\male\female &= (P\female_{16\leq 66''})\ (P\male_{4\leq 66''\leq 7}) \\
P\male\female &= (.0743)\ (.0334) \\
P\male\female &= .0025
\end{aligned}
$$

Stated as odds, the chances are about 25 out of 100,000 that the spectator was as short as 66 inches.

(657) By the same method it can be shown that the probability the spectator was at least 70 inches in height is 0.87. That is, the odds are about 9 to 1 that he was as tall as estimated from the street signs.

Conclusions

(658) By two independent tests, it can be shown that the spectator alleged to be Milteer was substantially taller than the Milteer's reported height of 64±2 inches. The first method provides a height estimate of about 70 inches through comparison with the reported dimensions of two street signs shown in the motorcade. The second demonstrates that the probability of the spectator's height falling within the range given for Milteer is statistically remote.

(659) The findings of both tests support the conclusion that the spectator was not Joseph Milteer.

(e) *The three tramps*

1. INTRODUCTION

(660) Immediately after the assassination, law enforcement officers conducted a search of the area behind the grassy knoll in which several railroad boxcars were situated. As a result of this search, approximately six to eight persons who appeared to be derelicts were taken either to the nearby Dallas County Sheriff's office, or to the Dallas Police Department for questioning. All were released without being booked, fingerprinted or photographed. (*222*) Among these "derelicts" were three men who, according to the arresting officers, had been found in a boxcar approximately one-half mile south of the assassination scene. (*223*) As the police led the three derelicts through Dealey Plaza to the sheriff's office, they were photographed by several press photographers. (*224*)

(661) When allegations of a CIA connection with President Kennedy's death emerged in the years following the assassination, these photographs received wide publicity in newspapers, television and in

the April 28, 1975 issue of Newsweek magazine. (*225*) It was claimed that two of the derelicts or "tramps," as they had come to be called, bore striking resemblances to Watergate burglars E. Howard Hunt and Frank Sturgis respectively. (*226*) Allegations have been made that Hunt, who had been a CIA employee in 1963, Sturgis, who, while not an employee, had been involved in CIA-related activities, had been together in Dallas on November 22, 1963 and had participated in the assassination as part of a CIA conspiracy. (*227*)

(662) In 1975 the Rockefeller Commission, investigating CIA activities within the United States and allegations concerning CIA complicity in the Kennedy assassination, requested the FBI to compare known photographs of Hunt and Sturgis, taken near the time of the assassination, with photographs of the tramps each was said to resemble. (*228*) After a photographic analysis of facial and statural characteristics of the men in question, the FBI concluded that "neither E. Howard Hunt nor Frank Sturgis appear as any of the three 'derelicts' arrested in Dallas, Tex., as shown in the photographs submitted." (*229*) In response to the 1975 Newsweek story, the CIA also conducted a physiological comparison of the Hunt and Sturgis photographs with the tramp photographs, and reached the same conclusion as the FBI. (*230*)

(663) Nevertheless, Warren Commission critics still view this issue as unresolved and the identity of the three tramps is still regarded as an important part of the conspiracy theories. (*231*) In addition to the Hunt and Sturgis connection, three other individuals, Thomas Vallee, Fred Lee Chrisman, and Daniel Carswell, who have been named as possible co-conspirators, have been suggested as likely tramp candidates.

(664) In an attempt to identify or exclude Hunt, Sturgis and these other individuals as one of the derelicts arrested by the Dallas Police Department, forensic anthropologists were asked to examine and compare photographs of the tramps and the suspected individuals.

2. ISSUES

(665) Can any of these individuals be positively identified or excluded as one of the three tramps?

3. MATERIALS

(666) *Three tramps.*—A series of 8 by 10 black and white copy prints depicting one or more of the tramps were examined. (See figs. IV–50—IV–56.) These were taken by press photographers as the detainees were being escorted through Dealey Plaza by Dallas police officers. A number of enlargements of the heads of the three individuals were also provided.

(667) Photographs of the following individuals were examined and compared with those of the tramps:

(668) *Daniel Carswell.*—Two photographs, one an 8 by 10 black and white lateral view (1963) and the other a 3 by 3 color frontal view (1969), were reviewed.

(669) *Fred Lee Chrisman.*—The only available photograph was a single undated black and white 8 by 10 print.

(670) *E. Howard Hunt.*—Twenty-six black and white photographs that span the assassination period and vary widely in type, pose, and quality were examined.
(671) *Frank Sturgis.*—A series of 38 black and white photographs, ranging widely in quality and varying from casual snapshots to studio photographs, were studied. They are undated but, based upon the subject's age and clothing styles, they appear to span the period of the assassination.
(672) *Thomas Vallee.*—One 8 by 10 black and white frontal view was analyzed.

4. CONCLUSIONS

(673) Daniel Carswell, E. Howard Hunt, Frank Sturgis, and Thomas Vallee were not the tramp(s) with whom they were being compared. Fred Chrisman strongly resembles one of the tramps, but, without analysis of additional photographic materials, no positive identification can be made.

5. ANALYSIS

(674) The three tramps have been arbitrarily identified "A," "B," and "C" according to their position, from left to right, in figure IV–50. All three are white males of medium stature and physique. Tramp A appears to be approximately 35 ±5 years old, tramp B about 30 ±5 years, tramp C, the eldest, about 50 ±10 years. Tramp B is the tallest, exceeding A and C (who are of approximately equal height) by about 3 to 5 inches. None of the men have any striking facial abnormalities or disfigurements. Their hands, shown in several photographs, display no abnormalities or amputations that might serve as clues to identification. Judging from his apparent gait, tramp A may have been slightly bow-legged. Tramp C appears to have been somewhat splay-footed.
(675) All three men are shabbily dressed, befitting their apparent status as vagrants. Tramp A, however, is the better attired, wearing well-fitting jeans and a tweed-like sports jacket, although this, judged by 1963 styles, was several years out of date. Tramp B is wearing ill-fitting slacks and a double-breasted suit coat. Tramp C, from his battered fedora to his worn-out shoes, has managed to achieve a sartorial effect similar to what one would expect had he been fired from a cannon through a Salvation Army thrift shop.
(676) While such clothing might be a disguise, their footwear seems consistent with their classification as vagrants. All three men are shod in worn, low-cut oxfords that appear to be leather-soled. Tramp C's shoes seem to be several sizes too large for him.

Tramp A

(677) Enlarged photos of this tramp were compared with those of Thomas Vallee who, a few weeks before the assassination, had been arrested in Chicago after making threats on the life of President Kennedy, Frank Sturgis, the anti-Castro soldier of fortune who participated in some of the illegal activities associated with the Watergate scandals, and Daniel Carswell. (See fig. IV–57, JFK exhibit F–172.)*

---

* Originally Sturgis was compared only with tramp B (see HSCA JFK hearings, vol. IV, pp. 374–77); the anthropologists were later asked to extend their comparison to include tramp A.

(678) Table I compares the facial indices of tramp A with those of Vallee, Sturgis, and Carswell. The figures enclosed in parenthesis along with indices of Vallee and Sturgis represent the difference between their indices and that of tramp A. Thus for the nasal index (No. 4), that of Vallee is 68, 3 points less than that of tramp A. This would suggest that Vallee had a slightly narrower nose (relative to its length) than that of the tramp. Nevertheless, when consideration is given to the possibility of variation in the index caused by the inevitable errors involved in taking measurements from the rather poor quality tramp photographs, such a difference is not too impressive. In contrast, the same index for Sturgis exceeds that of tramp A by 15 points, indicating that, compared to the tramp's his nose was much broader in relation to its length. This difference is considerable, and far outweighs any variation caused by technical error.
(679) When the differences in the other indexes of the series were similarly examined, it was determined that generally the values of Vallee's indices more closely approximated those of the tramp than the indices of either Sturgis or Carswell. Four of Vallee's indices differ by less than 5 points from tramp A's and the largest difference is 7 points. These results were indicative of a fair resemblance between Vallee and tramp A. Sturgis' indices vary between 2 and 15 points from those of the tramp. The average deviation of all seven indices is 4 for Vallee, 7 for Carswell, and 8.6 for Sturgis. Therefore, on the basis of metric analysis, Vallee's resemblance to the tramp is more impressive than that of either Sturgis or Carswell. An average deviation of 5 or less may be considered as evidence of a strong resemblance between the subjects of analysis.
(680) In addition to this facial index analysis, the subjects' morphological features were also closely examined. Strong differences in their features were discerned between those of tramp A and Vallee, Sturgis, and Carswell.

Sturgis

(681) 1. *Hair.*—Both Sturgis and Tramp A have dark hair with a strong transverse wave. Tramp A's bilateral recession of the hairline, however, is more advanced than is observed on any of the Sturgis photographs. Sturgis also has a short, low part line extending from the apex of lateral hairline recession on the right side of the head—a feature not present in tramp A.
(682) 2. *Forehead.*—Tramp A's forehead is characterized by a strong vertical interciliary sulcus (frown line) that extends upward to a point about three-quarters of the distance between the level of his eyebrows and hairline. This sulcus is a little to the left of the midline of his forehead so that its lower end is located very close to the medial (inner) end of his left eyebrow. This wrinkle, of course, is probably somewhat accentuated by the tramp's deep frown. In several photographs of Sturgis shown in a similar facial expression, however, this deep furrow is not observed. Instead, Sturgis has a short, almost dimple-like, vertical interciliary line situated slightly to the right of the midline of the forehead.
(683) 3. *Eyebrows.*—The eyebrows of both men are similar in form (low, weakly arched). In the tramp, however, they are more narrowly separated than in Sturgis. In the former, they are heavy throughout

their length; in the latter, the lateral (outer) half of the eyebrows is scantily haired.

(684) 4. *Nasal form.*—Tramp A's nasal profile is straight, ending in a sharp and angular nasal tip. His nasal tip is horizontal or perhaps slightly depressed. Sturgis has a slightly convex nasal profile with a full, fleshy, and slightly elevated tip.

(685) 5. *Mouth.*—The Tramp has a relatively wide mouth with thin membranous lips. Each end of the mouth terminates in an oblique furrow (angulus oris sulcus). Sturgis' mouth is narrower with full lips; the angular furrows at the ends of the mouth are not as prominent as those of the Tramp.

(686) 6. *Chin.*—The chin of the Tramp is low, moderately projecting and has a relatively narrow, slightly squared lower border. Sturgis' chin is very deep, strongly projecting with an extremely wide, square, lower border. It is also distinguished by a well-marked median cleft—a feature not observed in the Tramp.

(687) 7. *Ears.*—The Tramp's ears are more projecting than those of Sturgis. The ear lobes of the Tramp are attached; Sturgis has free lobes. In the Tramp, the intertragal notch is extremely narrow, whereas in Sturgis, it is wide.

(688) 8. *Physique.*—Throughout the numerous series of photographs, Sturgis is characterized by a massive, muscular body build with some suggestions of a tendency toward corpulence. The Tramp, while well-muscled, is thin and wiry. In somatotypic terms, Sturgis would be classified as an endomorphic mesomorph; the Tramp as a mesomorphic ectomorph. Stated more plainly, Sturgis is built like a defensive guard, the tramp like an offensive quarterback. No statural data on either man was available but if it were assumed that they were of equal height, Sturgis would probably outweigh Tramp A by at least 20 to 40 pounds.

(689) To summarize, Frank Sturgis differs strongly from Tramp A in numerous metric and morphological features as well as in overall physique. Most of these features relate more to the underlying skeletal framework than to superficial soft tissues and, therefore, could not be effectively altered by disguise. For example, the massively squared, deep chin of Sturgis could not be altered into the low, more gracile chin of Tramp A. In conclusion, Frank Sturgis can be excluded as a candidate for the identification of Tramp A.

(690) *Vallee.*—As noted previously, Thomas Vallee resembles Tramp A more strongly in facial indices than Sturgis. There are also some similarities between the Tramp and Vallee in morphological traits. Thus, the contour of the hairline, the projection and general shape of the ears (except for the lobes) and the height and contour of the chin are much alike. Offsetting these resemblances, however, are the following features:

(691) 1. *Forehead.*—The strong vertical interciliary furrow of the Tramp is not present in Vallee.

(692) 2. *Eyebrows.*—These are laterally sparse in Vallee, but are heavy throughout in the Tramp.

(693) 3. *Mouth.*—Vallee has a small mouth, whereas the Tramp's is relatively wide. The upper lip is longer in Vallee. The angular furrows marking the corners of the mouth in the Tramp are not present in Vallee.

(694) 4. *Ears.*—The Tramp has attached lobes, Vallee's lobes are free.

(695) 5. *Nose.*—The strongest morphological differences between Vallee and the Tramp are in nasal structure:

(*a*) Nasal root—Very broad in Vallee, narrow in Tramp A.

(*b*) Nasal bridge—Wide, low, and concave in Vallee; narrow, salient and straight in Tramp A.

(*c*) Nasal tip—Rounded and extremely elevated in Vallee; angular and slightly depressed in Tramp A.

(*d*) Nostrils—In Vallee, the margins of the nostrils recede upward to such an extent that their interiors are fully exposed. This condition is sufficiently extreme to be classified as a disfiguring trait. The nostril margins are of normal configuration in Tramp A.

(*e*) In Vallee, two wart-like growths are present in the nasal region. The smaller is located just above the lower margin of the left nostril; the larger growth is on the cheek immediately adjacent to the margin of the left nostril. Neither feature is observed in the photographs of Tramp A, although the larger of these two structures is sufficiently sharp to allow visualization if it were present in the photograph.

(696) In conclusion, despite some strong metric resemblance between these two individuals, they are sufficiently dissimilar in morphological features to exclude Vallee as being Tramp A.

Carswell

(697) Of the three men who have been proposed as Tramp A, the resemblance between the latter and Carswell is the least impressive. As noted previously, they diverge in facial index values by an average of 7.0 points. Carswell's face is relatively long and narrow; Tramp A's is short and broad. This length difference is especially expressed in the lower face with Carswell's chin and upper lip being very long when compared to the Tramp's. Carswell's nose is also much longer, relative to its breadth. Differences in ear structure are also striking. In the Tramp, the lobes are attached whereas in Carswell the lobes are "welded"—that is, they attach to the sides of cheek with no discernible lobe at all. The antihelix of the ear (the elevated ridge just in front of and parallel to the outer margin of the ear) is well developed in Tramp A, but very poorly developed in Carswell.

Tramp B

(698) Photos of Frank Sturgis and Daniel Carswell* were compared with those of Tramp B. (See Figure IV–58.) Table II compares the facial indices of Tramp B with those of Sturgis and Carswell.

Sturgis

(699) In terms of these indices, Sturgis most closely resembles Tramp B in mouth height relative to lower face height (No. 5), the length of his ear lobe relative to the total ear length (No. 6), and the total ear length relative to face height (No. 7). He is more divergent in the remaining indices. The average deviation between the six facial indices analyzed here is 4.0 points. This is low enough to

---

***Originally, Carswell was compared only with Tramp A (see HSCA-JFK Hearings vol. IV, pp. 374–77); the anthropologists were later asked to extend their comparison to Tramp B.**

make it impossible to rule out Sturgis on the basis of metric traits alone.

(700) The following morphological differences, however, between Sturgis and Tramp B indicate that they are not the same person:

(701) 1. *Hair.*—Sturgis is a very dark brunette with strongly waved hair; Tramp B has medium-dark hair with a slight wave.

(702) 2. *Hairline.*—The hairline of Tramp B shows more bilateral recession than is observed in Sturgis.

(703) 3. *Nose.*—Tramp B has a concave nasal profile with a rounded, slightly bulbous, nasal tip. Sturgis' nasal profile is slightly convex and the nasal tip is less bulbous than that of the Tramp.

(704) 4. *Chin.*—The most striking difference between the two men is the form of the chin. Sturgis' is massive and square; Tramp B has a small and rounded chin.

(705) 5. *Ears.*—Tramp B's ears are considerably more projecting than those of Sturgis which are rather close set.

(706) 6. *Physique.*—Tramp B appears to be considerably more linear in body build than Sturgis, who is broad and stocky in physique.

Carswell

(707) Carswell's resemblance to the Tramp based upon the facial indices was not nearly as impressive. Two of his facial indices, forehead height relative to total face height (No. 1) and lobe length relative to ear length (No. 6) differ from those of the Tramp by 12 and 13 points, respectively. These differences strongly exceed any divergence that might be introduced by technical error. The average deviation between the values of all six indices is 5.8 points. This deviation is sufficiently high to exclude Carswell as Tramp B on metric features alone.

(708) Strong differences in morphological features are also observed between Carswell and Tramp B. Carswell has a longer face relative to its breadth than the Tramp. Carswell's nose is thin with a sharply defined tip whereas the Tramp has a short, relatively broad nose with a rather bulbous tip. Carswell has a longer chin than the Tramp. The most striking difference between the two men is in the shape of their ears. Carswell's are essentially lobeless, that is, the lower margins of the ear attach directly to the cheek; Tramp B has well-developed lobes. In Carswell, the antihelix (the elevated ridge just in front of and parallel to the outer margin of the ear) is very weakly developed; in the Tramp, this structure is strongly developed and prominent.

(709) In conclusion, both Carswell and Sturgis can be excluded as being Tramp B.

Tramp C

(710) Photographs of Fred Lee Chrisman, a right-wing activist implicated in the Garrison investigation, and E. Howard Hunt, a principal figure in the Watergate burglaries and an employee of the U.S. Central Intelligence Agency at the time of the Kennedy assassination, were compared with Tramp C. (See fig. IV-59.) The indices of Hunt, Chrisman, and Tramp C are compared in table III.

(711) In comparing Hunt with Tramp C, the average difference in the six indices of the two men is 9.0, a value sufficiently high to suggest no particularly strong resemblance in facial proportions. In addition, in comparing the photographs of the Tramp to those of Hunt taken in

the late 1950's and early 1960's, the following morphological differences were noted:

(712) 1. *Forehead.*—Tramp C has several well-developed transverse frontal sulci and a strong vertical interciliary sulcus. These are not observed in Hunt who, even in photographs taken in later years, has only slightly developed transverse frontal and interciliary furrows.

(713) 2. *Nose.*—The Tramp has a relatively broad nose with a bulbous, fleshy nasal tip. The nasal tip is not depressed. Hunt has a narrow nose with a salient nasal bridge and an angular, moderately depressed nasal tip.

(714) 3. *Mouth.*—Tramp C has thick, full membranous lips; Hunt is thin-lipped.

(715) 4. *Cheek.*—Tramp C has well-developed nose-labial folds whereas in Hunt these are only incipiently developed in his photographs taken at about the time of the assassination.

(716) 5. *Ear.*—From his photographs, it is apparent that Hunt underwent surgery to correct his rather projecting ears. The date of this operation was not determined but from the photographs, it would appear to have been within a few years before or after the assassination. In degree of projection, the Tramp's ears appear to more closely match Hunt's pre-surgical condition.

(717) Two features not influenced by the surgery are strongly different in the two men. One of these is the helix, the fold of flesh that forms the outer rim of the ear. In the Tramp, this fold is wide and prominent whereas it is narrower and more weakly developed in Hunt. The second difference is in the antihelix, the secondary fold that roughly parallels the helix inside the ear. This structure is strongly developed in the Tramp and, in fact, its lower portion appears to extend beyond the helix. In Hunt, the antihelix is weakly developed.

(718) 6. *Scars.*—In the Tramp there is a pit-like, ovoid scar about 1 centimeter in diameter located immediately above the lateral end of his right eyebrow. This feature is not observed in any of the Hunt photographs provided for examination.

(719) 7. *Age.*—In general facial tone, age lines and other features, Tramp C appears to be at least a decade older than Hunt.

(720) From the observed differences in metric and morphological features, E. Howard Hunt can be confidently excluded as being Tramp C.

(721) *Chrisman.*—A camparison of a single undated full-face photograph of an individual identified as Fred Lee Chrisman was also made with those of Tramp C. His mouth is slightly open and he appears to have been speaking at the time the photograph was made. The subject is a white male who appears to be about 60 ± 5 years of age. In general, the index difference between Chrisman and Tramp C is low, ranging between two and six points with a mean difference of four index points. This is less than one-half the average index difference (nine) observed between E. Howard Hunt and Tramp C. Such a low value suggests a strong resemblance between Tramp C and Chrisman in general facial configuration.

(722) Tramp C appears to be approximately a decade younger than Chrisman.* The similarities in morphological traits between Tramp C and Chrisman are nevertheless impressive.

---

*Therefore, to obtain a more definitive interpretation, it would be helpful to establish the date of the Chrisman photograph.

(723) 1. *Hairline.*—Although Tramp C is wearing a hat, it is positioned far enough back on his head to reveal his hairline. It appears to be continuous and uninterrupted by a part or any strong recession due to balding. It is thus of the same general configuration observed in Chrisman.
(724) 2. *Forehead.*—Both Chrisman and Tramp C are characterized by several strongly developed transverse frontal sulci "worry lines". These are more accentuated in Chrisman as would be consistent with his apparent greater age. Unfortunately, these wrinkles are not shown with sufficient clarity in the Tramp to allow a detailed comparison of their pattern. Differences observed in this region include the circular, pit-like scar located immediately lateral to the outer end of the left eyebrow of Tramp C and the strong vertical interciliary sulcus of the Tramp, neither of which are discernible in the Chrisman photograph.
(725) 3. *Eyebrows.*—In both men, the eyebrows are low and weakly arched. In the Tramp, however, they appear to be more widely separated than they are in Chrisman.
(726) 4. *Eyes.*—Both men have heavy medial eyefolds which tend to obscure the upper lids, lending their eyes a "hooded" aspect. Also both display well-developed oblique palpebral sulci that gives them a somewhat "baggy-eyed" appearance.
(727) 5. *Nose.*—In Tramp C, the nasal root appears to be somewhat broader than in Chrisman. In both men, the lower nasal region is characterized by a full, fleshy tip.
(728) 6. *Mouth.*—Both men have relatively small mouths. The membranous portion of Chrisman's upper lip appears to be extremely thin whereas that of the Tramp is moderately full. The nasolabial fold is strongly developed in Tramp C but not present in Chrisman.
(729) 7. *Chin.*—Both men have prominent chins with squared lower margins. In both, platysmal folds have developed to give them a rather "jowly" appearance.
(730) 8. *Ears.*—No morphological inconsistencies in the ears of the two men are observed.
(731) In brief, Chrisman resembles Tramp C rather strongly in both metric and morphological features. These similarities, derived from the analysis of a single undated photograph of Chrisman, are in no way sufficient to establish a positive identification. Nevertheless, they are strong enough to suggest that further analysis, based on more fully documented Chrisman photographs, should be considered, unless independent evidence excludes Chrisman's presence in Dallas on November 22, 1963.

TABLE I.—COMPARISON OF FACIAL INDICES OF TRAMP A WITH THOSE OF VALLEE, STURGIS, AND CARSWELL

No. and index (Times 100)	Tramp A	Vallee	Sturgis	Carswell
1. Forehead height: Total face height	31	37 (6)	33 (2)	28 (3)
2. Nose length: Lower face height	47	46 (1)	33 (14)	42 (5)
3. Chin eminence height: Lower face height	20	23 (3)	31 (11)	27 (7)
4. Nose breadth: Nose length	71	68 (3)	86 (15)	76 (5)
5. Mouth height: Lower face height	33	34 (1)	40 (7)	36 (3)
6. Lobe length: Ear length	22	29 (7)	30 (8)	42 (20)
7. Ear length: Total face height	36	29 (7)	33 (3)	30 (6)
Mean deviation		4.0	8.6	7.0

TABLE II.—COMPARISON OF FACIAL INDICES OF TRAMP B WITH THOSE OF FRANK STURGIS AND DANIEL CARSWELL

No. and index (times 100)	Tramp B	Sturgis	Carswell
1. Forehead height: total face height	41	33 (8)	28 (13)
2. Nose length: Lower face height	40	33 (7)	42 (2)
3. Chin eminence height: Lower face height	27	31 (4)	27 (0)
4. Nose breadth: Nose length			
5. Mouth height: Lower face height	38	40 (2)	36 (2)
6. Lobe length: Ear length	30	30 (0)	42 (1[illegible])
7. Ear length: Total face height	36	33 (3)	30 (6)
Mean deviation		4.0	5.8

TABLE III.—COMPARISON OF FACIAL INDICES OF TRAMP C WITH THOSE OF E. HOWARD HUNT AND FRED LEE CHRISMAN

No. and index (times 100)	Tramp C	Hunt	Chrisman
1. Forehead height: Total face height	29	42 (13)	33 (4)
2. Nose length: Lower face height	35	46 (11)	41 (6)
3. Chin eminence height: Lower face height	20	30 (10)	18 (2)
4. Mouth height: Lower face height	40	50 (10)	34 (6)
5. Lobe length: Ear length	30	32 (2)	27 (3)
6. Ear length: Face height	36	28 (8)	33 (3)
Mean deviation		9.0	4.0

PHOTOGRAPHS TAKEN OF THE THREE TRAMPS ARRESTED IN DEALEY PLAZA, NOVEMBER 22, 1963

FIGURE IV–50.

FIGURE IV–51.

FIGURE IV-52.

FIGURE IV-53.

FIGURE IV–54.

FIGURE IV–55.

FIGURE IV–56.

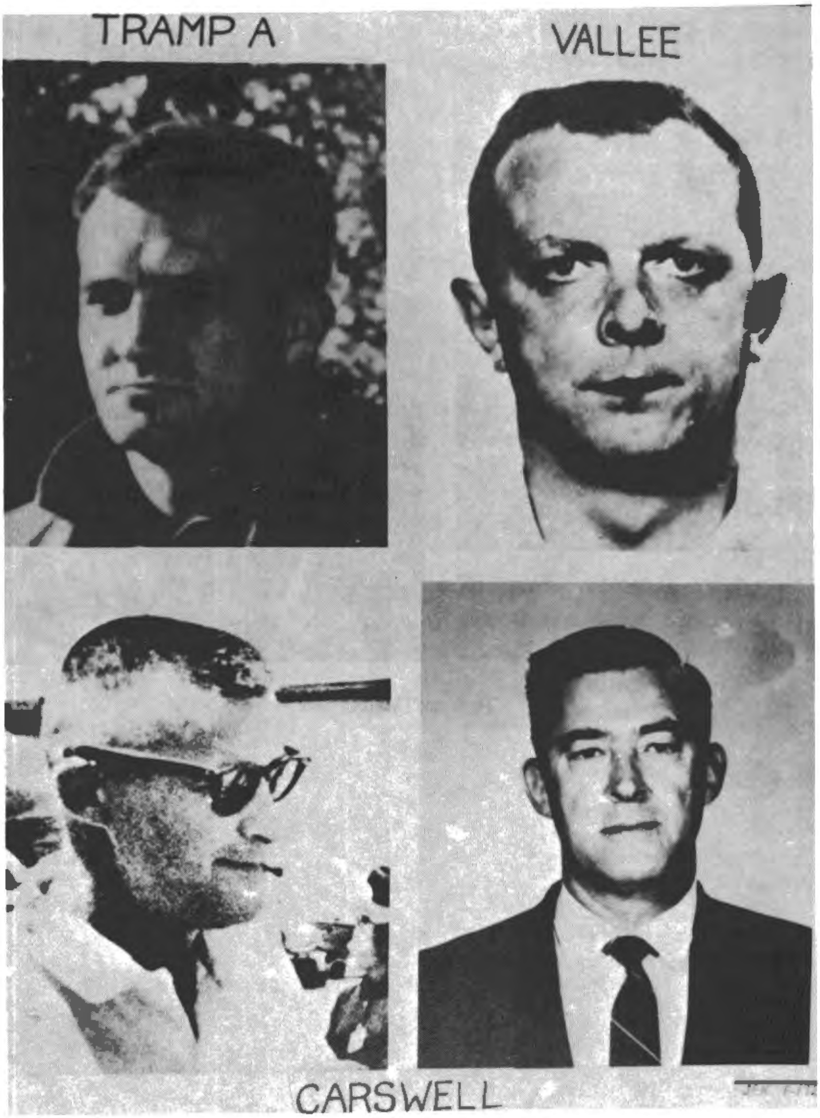


FIGURE IV–57.

FIGURE IV-58.

FIGURE IV-59.

(*f*) *The "Second Oswald" Theory—Comparison of Oswald Facial Photographs*

1. INTRODUCTION

(732) Various conspiracy theories have centered around the hypothesis that a double of Lee Harvey Oswald played a part in the assassination of President Kennedy. The theorists themselves appear to disagree on the origin and role of this "Second Oswald." Nevertheless, all agree that in at least one stage of his career between the

time Oswald defected to the Soviet Union and the assassination, he was impersonated by a double. (*232*) To investigate this possibility, the anthropology consultants examined a series of Oswald photographs ranging in time from his Marine Corps enlistment to his arrest in Dallas after the assassination.

2. ISSUE

(733) Is there any photographic evidence of an Oswald imposter?

3. MATERIALS

(734) The collection of photographs pertaining to the Kennedy assassination and Warren Commission investigation includes several dozen of Oswald (or, possibly, his double). As one might expect, they vary widely in pose, facial expression, lens-subject distance, and image quality. From these, it was possible to select nine in which (1) the facial features were fairly well defined, (2) the pose was either nearly full-face or true profile, and (3) represented the subject during various key episodes of his life from the time he was a Marine until the assassination. (See figs. IV–60, IV–61, JFK exhibits 556–557.)

FIGURE IV–60.

FIGURE IV-61.

In addition, two photographs of definitely poorer quality were selected for analysis. These were two of the controversial "backyard photographs;" they differ from the others in that the direction of lighting was from almost directly overhead and the facial image was somewhat more poorly defined. (See figs. IV-18 and IV-20.)

(735) In addition to the Oswald photographs, data were included from three photographs of Billy Lovelady, taken in the early 1960's. Lovelady was a fellow employee of Oswald's at the Texas School Book Depository and his strong physical resemblance to Oswald was a source of controversy and confusion regarding the "man in the doorway" photograph.* The inclusion of Lovelady's facial indices in our analysis provides a convenient control or yardstick to measure the variation observed in the facial indices derived from the Oswald photographs.

4. METHODS

(736) This analysis is based on 15 indices derived from 16 measurements of the head and face.** The measurements were taken to the nearest 1 millimeter from 8-by-10-inch, black-and-white enlargements of the subject's face. The indices for both Oswald and Lovelady are given in table I. There are some missing values for the three profile views of Oswald. This is because certain measurements necessary for calculating these indices cannot be obtained from a profile photograph. Also, a few indices could not be calculated for the full-face photographs because lighting, image clarity, or other factors would not permit the necessary measurements to be made with sufficient accuracy.

*See par. 759 infra.

**See addendum A, pars. 746–748 infra.

42-370 O - 79 - 18

(737) In order to reduce this complex set of individual values to more meaningful statistics, one of the methods long employed by anthropologists was used to compare both living and fossil populations. The method selected was Penrose's distance statistic, which has an advantage over more sophisticated multivariate methods in that it is fairly simple to compute, but still gives an acceptable approximation of the morphological differences between the groups. (*233*) The use of more elaborate methods did not seem justified in view of the small sample sizes involved.

(738) This method reduces a set of complex variables that characterize two or more groups to a pair of coefficients that reflect the groups' overall difference in size and shape.

(739) To apply this method to the present problem, the index data was grouped chronologically to represent Oswald at various significant periods of his life:

1. Marine Corps.
2. Russia.
3. Backyard (Dallas).
4. New Orleans.
5. Arrest (Dallas).

(740) The data were then studied to determine whether the face of the individual shown in the Oswald photographs, taken during any one of the first four of these periods (Marine Corps, Russia, backyard, New Orleans), differed morphologically from the face of the man who was arrested in Dallas after the assassination. If such a difference was found, it might suggest that a double was involved.

5. CONCLUSIONS

(741) There are no biological inconsistencies in the Oswald photographs examined that would support the theory that a second person, or double, was involved. The variation observed is that expected in an array of photographs taken by different cameras with varying lens, camera angles, lighting, and other technical differences.

(742) It is not, however, possible totally to dismiss the "second Oswald" hypothesis on the basis of this negative finding. For example, it is possible that a double—if one existed—may not have been included in the series of photographs examined. There is also a possibility, however remote, that such a double was such a perfect twin of Oswald that no detectable metric or morphological differences are discernible in the photographic record.

6. ANALYSIS

(743) The results of the analysis are shown in the accompanying graph. (See fig. IV–62.) The origin of the graph represents the facial indices of the Dallas arrestee. The various points on the graph represent the other Oswald photographic sets as well as that of Billy Lovelady. The points were determined by plotting the Penrose size coefficient against the shape coefficient. The closer a point falls to the origin, the greater the similarity in facial morphology between the individual represented in a particular set of photographs and the person arrested in Dallas. As might be expected, the point representing Billy Lovelady lies much farther from the origin than those represent-

ing Oswald. Of the latter, the backyard photographs are the most divergent.

(744) Compared to Lovelady, who strongly resembles Oswald, the Marine, Russia, backyard, and New Orleans photographs cluster rather closely to the origin. It seems highly probable that the relatively small deviation observed in the Oswald data can be attributed to inevitable error involved in locating landmarks and making measurements from the photographs rather than to the existence of an Oswald double.

(745) In addition to the analysis of facial indices described above, other facial features were compared. For example, in the three profile views, the angle of the nasal bridge in relation to the face was 37° in all three cases and the angle between the nasal septum and the facial plane varied by less than 1°. The ears are relatively distinctive in shape and are strikingly similar in all photographs where they can be examined. The hairline, if one makes allowance for the passage of time, is quite compatible in all photographs examined. Also, there was no evidence of any incompatible anomalies, scars or other characteristic features suggesting different individuals in the various photographs.

TABLE I.—FACIAL INDICES OF LEE HARVEY OSWALD AND BILLY N. LOVELADY

Index No.	MMT	Marine	Russia			Backyard		New Orleans		Dallas arrest			Lovelady		
		1	1	2	3[1]	1	2	1	2[1]	1	2	3[1]	1	2	3
1	9/1	65.3	68.1	69.7		70.1	74.7	68.5		63.5	68.7		65.8		65.4
2	9/2	85.2	83.9	86.8		83.7	85.0	83.5		86.4	84.8		75.8		68.0
3	3/2	36.5	33.9	29.7		32.6	30.0	33.0	30.4	36.0	34.1	30.7	36.4	32.4	32.0
4	4/5	43.7	41.3	42.0	42.0			36.1	37.8	45.7	42.0	39.1	38.1	32.6	26.2
5	14/5	20.0	22.6	22.1	20.2	26.1	22.2	22.9	20.3	23.4	21.6	21.9	26.5	28.3	29.4
6	11/9	90.8	87.2	86.1		86.6	86.8	90.8		86.1	85.7		86.0		100.0
7	15/4	75.0	82.7	74.0				79.2		73.5			79.3	84.0	
8	8/2	23.5	24.1	24.2	25.3	26.5	25.0	24.2	23.5	23.2	23.4	25.0	24.2	28.5	28.0
9	8/5	33.7	36.0	33.6	34.9	40.0	37.0	36.1	32.4	35.8	35.2	34.4	37.2	42.2	41.2
10	12/11	87.6	90.2			77.5		89.8		87.1	87.5				85.3
11	16/6	32.4	34.2	39.3		31.2	30.8	32.1		30.0			40.2	47.8	46.1
12	7/6	33.8	34.2	33.3		40.6		33.9		30.0	34.1		37.0	41.1	46.1
13	10/11	24.7	24.4	24.9				21.7		23.1	23.9		27.9	29.1	26.5
14	13/12	30.8	32.4		6.0	40.0		32.2		34.6	32.1				48.3
15	6/2	32.2	31.2	30.8	3	32.6	32.5	30.8	34.3	32.0	31.1	35.2	27.7	26.5	26.0

[1] Profile.

TABLE II.—MEAN INDEX VALUES OF LEE HARVEY OSWALD AND BILLY N. LOVELADY

Index No.	Oswald					Lovelady	Mean	Standard deviation
	Marine	Russia	Backyard	New Orleans	Dallas arrest			
1	65.3	68.9	72.4	68.5	66.1	65.6	67.8	2.71
2	85.2	85.4	84.4	83.5	85.6	71.9	82.7	5.33
3	36.5	31.8	31.3	31.7	33.6	33.6	33.1	1.95
4	43.7	41.8		36.9	42.3	32.2	39.4	4.76
5	20.0	21.6	24.2	21.6	22.3	28.1	23.0	2.86
6	90.8	86.6	86.7	90.8	85.9	93.0	89.0	2.94
7	75.0	78.4		79.2	73.5	81.6	77.5	1.46
8	23.5	24.5	25.8	23.8	23.9	26.9	24.7	1.34
9	33.5	34.8	38.5	34.2	35.1	40.2	36.1	2.63
10	87.6	90.2	77.5	89.8	87.3	85.3	86.3	4.66
11	32.4	36.8	31.0	32.1	30.0	44.7	34.5	5.51
12	33.8	34.0	40.6	33.9	32.0	41.4	36.0	3.99
13	24.7	24.4		21.7	23.5	27.8	24.4	2.22
14	30.8	32.4	40.0	32.2	33.4	48.3	36.2	6.76
15	32.2	32.7	32.6	32.6	32.8	26.8	31.6	2.37

TABLE III.—*Measurements used to derive indices for comparison of Oswald photographs*

1. Total head height — Vertical distance from the top of the head to the bottom of the chin (*vertex* to *menton.*) N.B.: some allowance for hair must be made in taking this measurement from a photograph.
2. Physiognomic face height — Distance from the midpoint of the hairline to the most anterior point on the lower forehead just above the nasal root depression (*trichion* to *glabella*).
3. Forehead height — Distance from the midpoint of the hairline to the most anterior point on the lower forehead just above the nasal root depression (*trichion* to *glabella*).
4. Nose length — Distance from the deepest point of the nasal root depression to the junction point between the nasal septum and the upper lip (*subnasion* to *subnasale*).
5. Total face height — Distance between the most anterior point on the lower forehead just above the nasal root depression and the lowest point on the chin (*glabella* to *menton*).
6. Ear length — Distance between the uppermost point on the helix of ear and the lowermost point on the earlobe (*superaurale* to *subaurale*).
7. Lobe length — Distance between the lowest point in the intertragic notch and lowest point of the earlobe (*inter-tragion* to *subaurale*).
8. Mouth height — Distance from the point of contact between the upper and lower lip and lowest point on the chin (*stomion* to *menton*).
9. Maximum head breadth — Horizontal distance across the broadest portion of the head. N.B.: Some allowance for hair must be made in taking this measurement from a photograph.
10. Interpalpebral breadth — Horizontal distance between the inner corners of the eyes (*biendocanthion breadth*).
11. Facial breadth — Maximum horizontal distance across the face (*bizygomatic breadth*).
12. Mandibular breadth — Horizontal distance between the angles of the jaws (*bigonal breadth*).
13. Chin width — Horizontal distance across the eminence of the chin.
14. Chin eminence height — Distance from the point of deepest depression between the lower lip and chin and the lowest point on the chin (*supramentale* to *menton*).

TABLE III.—*Measurements used to derive indices for comparison of Oswald photographs*—Continued

15. Nasal breadth	Maximum horizontal breadth across the nasal wings (*bialar breadth*).
16. Lateral ear projection	Horizontal distance from the lateral-most point on the outside margin of the ear to the junction of the ear with the face.

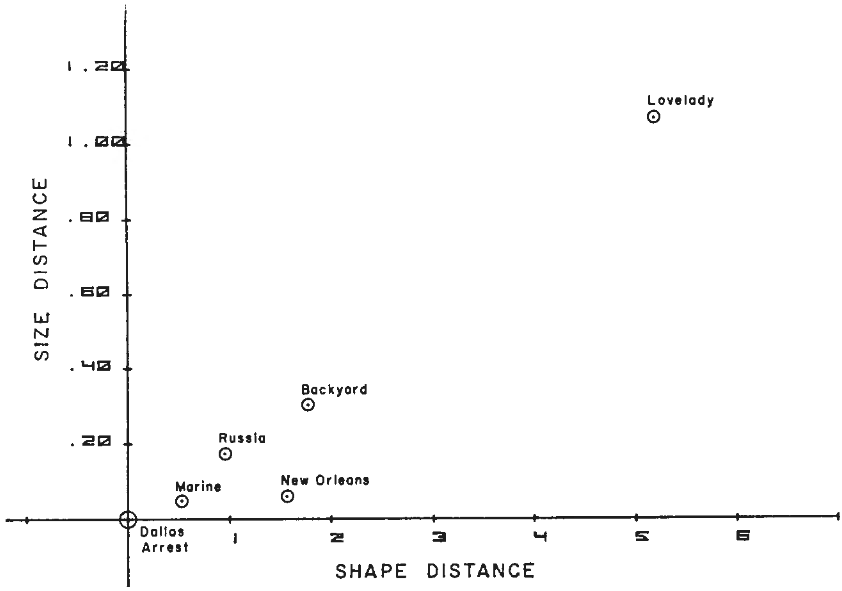


FIGURE IV–62.—Penrose Size and Shape Coefficients Calculated From Facial Indices of Lee Harvey Oswald and Lovelady Photographs. Origin of the Graph Represents Dallas Arrest Photographs.

ADDENDUM A

CALCULATION OF PENROSE SIZE AND SHAPE COEFFICIENTS

(746) Table I gives the individual indices calculated from the measurements taken from the photographs of the series under examination. These were averaged for each photographic set to give the mean indices shown in Table II. In some instances these are, of necessity, based on a single value. The mean and standard deviation of the index values of the photographic sets (including Lovelady's) were then computed. These statistics are also given in Table II.

(747) The index values were then converted to standard deviation units (d-values). The Penrose coefficients were calculated from the d-values, using the following formulae:

Distance coefficient:	*Formula*
Size	$C_Q^2=\left\{\sum^{n}(d)\right\}^2/n^2$
Shape	$C_s x\frac{n-1}{n}=\sum_{1}^{n}(d^2)/n-\left\{\sum_{1}^{n}(d)\right\}^2/n^2$

(748) The size and shape coefficients calculated for the various photographic sets and plotted in Table I are as follows:

	Marine	Russia	Backyard	New Orleans	Lovelady
Size equals $C^2{}_Q$	0.049	0.172	0.303	0.060	1.07
Shape equals $C^2{}_Z \times \frac{14}{15}$	.480	.888	1.647	1.460	4.83

ADDENDUM B

Oswald Height and Proportion Studies*

INTRODUCTION

(749) Several Warren Commission critics have alleged that substantial differences exist in the reported heights and facial characteristics among different photos and other measurements purported to represent Lee Harvey Oswald.(*234*) For example, differences of as much as 2 inches in height exist between an early Marine Corps induction photo of Oswald in front of a height chart (see fig. IV–63, JFK exhibit F–166), reported height measurements of Oswald,(*235*) measurements of the Oswald corpse in Dallas, and another height chart photograph of Oswald (see fig. IV–64). The Marine photograph, which allegedly depicts Oswald with a 13-inch head (measuring from the bottom of his chin to the top of his head), is also said to be inconsistent with his true facial measurements.(*236*) (See fig. IV–63). On this basis, it has been alleged that these differences are evidence of different individuals purporting to be Lee Harvey Oswald.(*237*)

1. ISSUE

(750) Are the differences in Oswald's body measurements, as detected from photographs of him standing against a height chart, probative in any way of an Oswald imposter theory?

2. ANALYTICAL APPROACH

(751) Two members of the photographic evidence panel were directed to take an independent series of photographs involving an individual of known height standing against a height chart. For each series of pictures, each person was to be photographed at different distances in relation to the height chart. The vertical orientation of the camera and its distance to the height chart was also subject to change at the photographer's discretion, but the camera was kept essentially horizontal at all times so that optical axis was level, that is, parallel to the ground.

(752) In addition, the forensic anthropologists on the photographic evidence panel were asked to provide information concerning discrepancies between measured and reported heights.

---

* This section was prepared under the direction of W. K. Hartmann and C. W. Kirk. For related testimony of Kirk, see HSCA–JFK Hearings, vol. IV, pp. 362–65.

3. CONCLUSION

(753) No probative weight should be given to an Oswald imposter theory based upon differences in Oswald's body measurements that have been detected from photographs of him standing against a height chart.

4. ANALYSIS

(754) First, panel member Dr. William K. Hartmann made a series of photographs of a subject standing with a height chart in the background, but with the subject standing at two different distances from the chart (shoulder-to-chart distance, 1 inch and 10 inches) and the camera at two distances typical of identification camera working distances (45 inches and 58 inches, respectively, from the height chart). To simulate the typical practice of adjusting the camera to the subject's approximate facial height (sometimes to eye level, sometimes to nose level, et cetera), the camera was elevated and lowered through a series of different vertical positions from chin level to the top of the hair. It was found that the subject's height, read from the height chart, ranged from 0 to 1¾ inches higher than the actual measured hair-top position during these photos. (*238*) *

(755) A second test involving similar procedures was conducted by Sergeant Cecil W. Kirk, of the District of Columbia Metropolitan Police Department's mobile crime lab, using departmental identification camera and height chart equipment. The subject's height in this experiment, as read from the height chart, increased one-half inch as the subject moved from a position with heels against the wall to a position with heels 8 inches out from the wall. In addition, while the height of the subject's head actually measured 8 inches from chin to head top, the readings on the height chart were approximately 12½ and 14 inches, thereby resulting in errors of 4½ and 6 inches, respectively. (*239*) (See fig. IV–65, JFK exhibit F–564.)

(756) The types of discrepancies obtained in the Hartmann and Kirk studies are attributable to parallax errors which, in this case, present a difference in scale between the images of the subject and the chart. Parallax errors occur because the plane of the subject's face or body is not in the same plane as the height chart to which it is being compared; since these two planes were photographed from a finite distance, nonparallel lines from camera to subject were introduced. The nonparallel lines diverge from the camera lens to the subject. Consequently, from a camera centered in front of the subject's face, the line of sight from the camera lens slopes upward past the top of the subject's head, yielding a higher reading on the background wall chart than the actual head-top height.

(757) Moreover, unless the subject photographed is standing with his back against the height chart at a correct distance from a properly

---

*In addition, because this particular subject's driver's license reported his height as 1¾ inches smaller than his actual measured hair-top position during the photography, the total discrepancy between the height chart readings and the driver's license ranged from 1¾ to 3½ inches. The reported height in the subject's driver's license was not checked until after the photography had been completed.

positioned camera equipped with an appropriate lens,* it is unreasonable to assume that the resulting picture is ever a precisely accurate indicator of both his height and head size. (*240*) For this reason, height charts are no longer commonly used in law enforcement and industrial security work. (*241*)

(758) Finally, the photographic evidence panel's board of forensic anthropologists advised that a diurnal variation in height of half an inch or more is common during the course of a day, with the subject generally being taller in the morning when the spine has been less compressed. (*242*) The board also cited to the panel an anthropological study by Robert M. White and Edmund Churchill ("The Body Size of Soldiers," U.S. Army Natic Laboratories, technical report 72-51-CE, 1971), which measured heights of 6,682 army personnel versus the heights these individuals reported for themselves. Typical discrepancies in height were 1.1 inches. Generally, men of average height (5 feet 9 inches) reported themselves 1.1 inches taller than their measured stature; relatively short men reported themselves about 0.8 inch taller; and relatively tall men reported themselves 1.2 inches taller.

---

* To get an accurate height measurement, the camera must be level and its optical axis must be level with the top of the head.

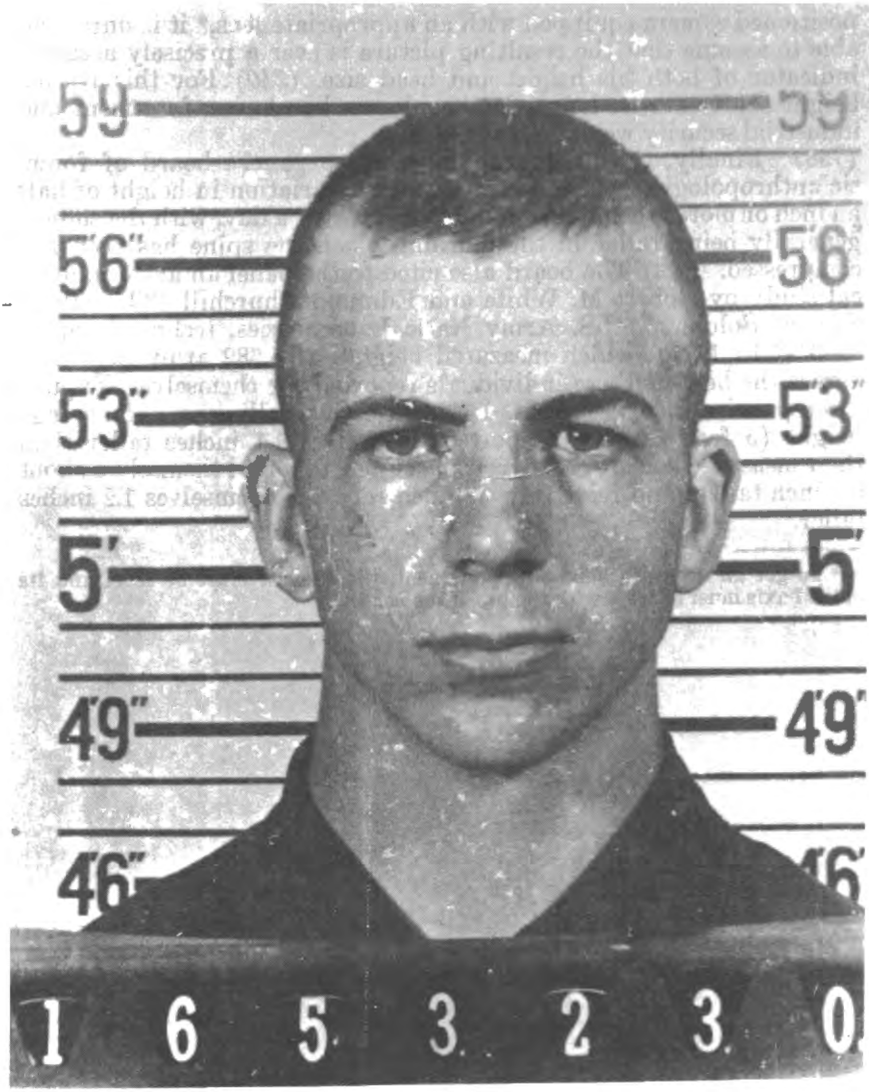


FIGURE IV-63.

Figure IV–64.—New Orleans arrest picture of Oswald in front of height chart.

FIGURE IV–65.

(g) *Comparison of photographs of Lee Harvey Oswald and Billy Nolan Lovelady with that of a motorcade spectator*

1. INTRODUCTION

(759) A widely publicized photograph taken by Associated Press photographer James W. Altgens within a few seconds after President Kennedy was first shot shows a spectator who bears a strong physical resemblance to Lee Harvey Oswald standing at the west end of the Texas School Book Depository entranceway. (See fig. IV–66, JFK exhibit F–559.) Altgens has stated that he took the picture of the presidential limousine, with the Texas School Book Depository entranceway in the background, just after he heard a noise "which sounded like the popping of a firecracker."(*243*)

(760) In evaluating the evidence that Oswald was in the sixth floor, southeast corner window of the Texas School Book Depository at the time of the shooting, the Warren Commission considered the allegation that the man shown in the doorway in the Altgens photograph was Oswald. The Commission concluded that the spectator was not Oswald, but rather another Texas School Book Depository employee, Billy Nolan Lovelady.(*244*) This conclusion was based upon Lovelady's identification of himself in the Altgens photograph(*245*) and upon statements of other persons who were present in the Texas School Book Depository entranceway at the same time.(*246*)

(761) Warren Commission critics have charged that there was insufficient basis for this conclusion (*247*), and have faulted the Commission for presenting "* * * no supporting visual evidence by which one can appraise the resemblance between Lovelady and the man in the doorway, or Lovelady and Oswald, although nothing less hangs on the accurate identification of the doorway man than Oswald's possible total innocence of the assassination" (*248*).

(762) This issue has also persisted because of reported discrepancies in connection with the clothing worn by the Altgens figure and Billy Lovelady on November 22, 1963. (*249*) In media prints of the Altgens photograph, the man appears to be wearing a long-sleeved shirt similar to the one in which Oswald was arrested. (*250*) (See fig. IV–67.) According to a memo written by FBI Director J. Edgar Hoover

to the Warren Commission after Lovelady had been interviewed and photographed in 1964 by FBI agents, (*251*) Lovelady was reported to have been wearing a short-sleeved red and white, vertically striped shirt. (See fig. IV–67.) Lovelady later explained that when he was interviewed and photographed by the FBI, he had not been told to wear the same shirt he had worn on the day of the assassination and that, in fact, he had been wearing a long-sleeved, plaid shirt when he was standing in the Texas School Book Depository doorway. (*252*) (See fig. IV–67.)

FIGURE IV–66.—TSBD doorway spectator seen in Altgens 1–6 photograph taken on Elm Street.

SPECTATOR IN TSBD DOORWAY:

Oswald Arrest Shirt

(Hughes Film)

Lovelady in Dealey Plaza Nov. 22, 1967 (Martin Film)

(Altgens Photo)

Lovelady in 1963 shirt (1976)

(Bell Film)

Lovelady photographed by FBI in 1964

FIGURE IV-67.—Photographic evidence evaluated in Robert Groden's shirt analysis.

(763) This contradiction was partially resolved by photo-optical work performed by Robert Groden, a Warren Commission critic and photographic consultant to the committee.* During his work with the committee Groden made photographically enhanced enlargements of the original 35 millimeter black and white Altgens negative and frames of the Bell, Martin, and Hughes color motion picture films, which also showed the spectator in the doorway, and detected a pattern of lines that correspond in pattern and color more closely to Lovelady's plaid shirt than to Oswald's tweed-patterned shirt. (*253*) (See figure IV-67.)
(764) Even so, in an effort to resolve the issue even more definitively, the photographic evidence panel's board of forensic anthropologists were requested to study the photograph of the spectator shown standing in the doorway.

2. ISSUE

(765) Is it possible to identify positively as either Lee Harvey Oswald or Billy Lovelady, the man, shown in the Altgens photograph standing by the doorway entrance to the Texas School Book Depository at the time of the President's assassination.

---

* Groden initially was among those who claimed the Altgens photograph could not be of Lovelady. See note 249 *supra*.

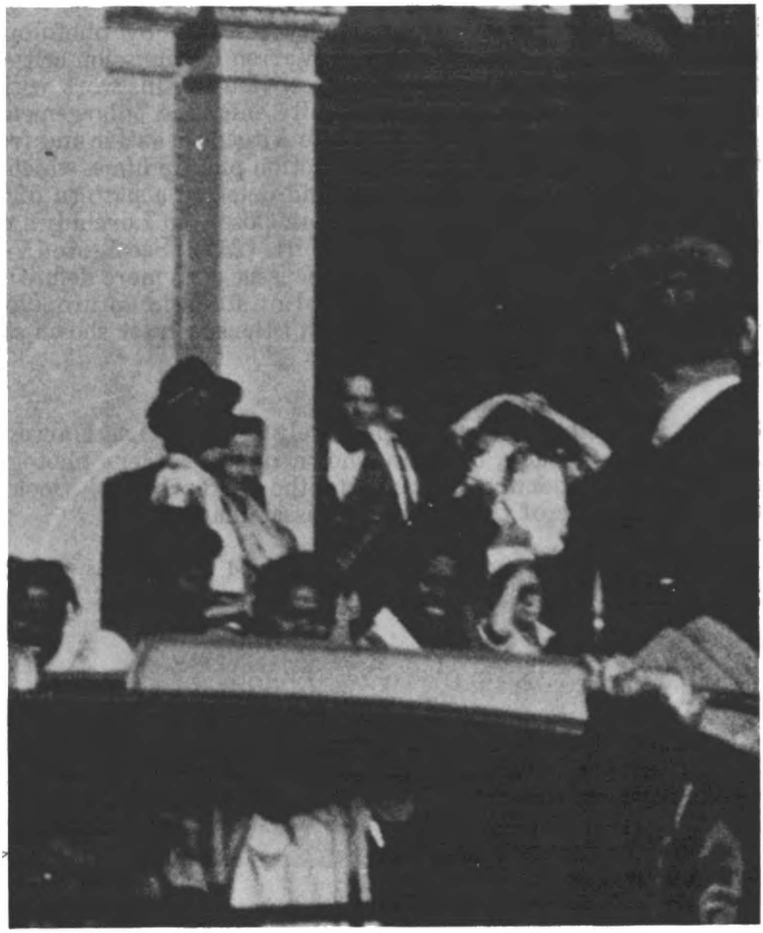


FIGURE IV-68.—Enlargement of spectator's face.
Altgens A.P.—World Wide Photos

FIGURE IV-69.—Oswald arrest in Dallas.

3. MATERIALS

Spectator

(766) In order to produce the clearest possible photographic images of the spectator in question, the Photographic Evidence Panel had black and white prints made from the original Altgens 35 millimeter negative at various contrasts, density levels and enlargements.* (*254*) They included various enlargements of the spectator's face such as that shown in figure IV-68. The anthropologists were furnished with a number of these prints.

Oswald

(767) A series of photographs of Lee Harvey Oswald, ranging from the time of his U.S. Marine Corps enlistment in 1956 to his arrest in Dallas in 1963, were provided to the anthropologists. While all were examined, those taken on the day of Oswald's arrest in Dallas received the closest scrutiny. (See, for example, Figure IV-69).

* The Altgens negative was not subjected to digital image processing because the image was blurred to the resolution limitations of the camera system, and, consequently, the Photographic Evidence Panel believed that computer assisted enhancement techniques would not aid in identifying the man in the doorway.

Lovelady

(768) Photographs of Lovelady were furnished which varied in date from 1959 to 1977. Of most interest were those taken near the time of the assassination. (See, for example, figure IV–70.)

FIGURE IV–70.—Billy Nolan Lovelady circa 1959–63.

4. CONCLUSION

(769) Due to the blurred quality of the enlargements of the spectator's image in the Altgens photograph, it was not possible either to identify or exclude positively Lovelady or Oswald. Based on a subjective assessment of the facial features of the spectator, however, it was determined that the man in the doorway bears a much stronger resemblance to Lovelady than to Oswald. Thus, assuming it is either Oswald or Lovelady, and not a third party, it appears highly improbable that the spectator is Oswald and highly probable that he is Lovelady.

5. ANALYSIS

(770) In comparing the photographs of Oswald and Lovelady, the general similarities in facial configuration between the two men were initially noted. Closer examination of the photographs revealed significant differences in the two men's facial proportions:*

(771) (*a*) *Facial length.*—Relative to facial breadth across the cheekbones, Lovelady's face is longer than Oswald's.

(772) (*b*) *Lower jaw breadth.*—Relative to facial breadth, measured across the cheekbones, Lovelady's lower jaw is narrower than Oswald's.

(773) (*c*) *Chin length.*—Relative to facial length, Lovelady has a somewhat longer chin than Oswald.

(774) (*d*) *Forehead breadth.*—Relative to the breadth of the face measured across the cheekbones, Lovelady's is broader than Oswald's.

(775) (*e*) *Nasal breadth.*—Relative to nose length, Lovelady's nose is broader than Oswald's.

(776) (*f*) *Nasal tip.*—Oswald's nasal tip is somewhat small and sharply contoured, whereas that of Lovelady is rounder and more bulbous.

(777) (*g*) *Forehead height.*—Due to hairline recession, Lovelady has a relatively higher forehead than Oswald.

(778) (*h*) *Hairline contour.*—Photographs of Lovelady and Oswald taken at a time close to the assassination indicate that overall Lovelady's central hairline had receded more than Oswald's, resulting in Lovelady's higher forehead, as noted above; in addition, the recession on both sides of Lovelady's temple is more sharply advanced than Oswald's. Lovelady's recession was not uniform, and he has a downward projection in the hairline about one inch to the right of the center of his forehead. This eccentrically placed "widow's peak" was not observed in any of Oswald's photographs.

(779) In summary, Lovelady's face is relatively longer than Oswald's, its length accentuated, in part, by more advanced balding and also by his narrower lower jaw and deeper chin. The asymmetry in his hairline is also a distinctive trait.

(780) The enlargements of the spectator's face are not of sufficient quality to permit accurate measurements. However, several features corresponding to Lovelady's traits can be discerned and subjectively assessed:

(781) (*a*) A relatively broad, high forehead;

(782) (*b*) Advanced recession of the hairline on each side of his head;

(783) (*c*) Interruption of the central hairline by a downward extension located slightly to the right of the center of the forehead;

(784) (*d*) A relatively long face with narrow jaws and a deep chin; and

(785) (*e*) A rather bulbous nasal tip.

---

*All measurements relative to these facial proportions are provided in the tables accompanying the text to pars. 732–748 supra.

(786) COMMENTS ON THE PANEL'S REPORT BY ROBERT GRODEN, CONSULTANT TO THE COMMITTEE

PREFACE

Robert Groden, a critic of the Warren Commission and coauthor of JFK: The Case for Conspiracy, was a photographic consultant to the committee. In this capacity, he provided background information on the issues that have been raised by the critics in the area of the photographic evidence; he also provided technical assistance to the committee in the area of photography. As such, he made an important contribution to the work of the committee. Though not a member of the committee's photographic evidence panel, he also gave panel members an extensive briefing on the prior work that had been done on various photographic issues; he also had additional input to the panel's work, either through communications with committee staff working with the panel or through participation in panel discussions. As a consultant to the committee, Groden was given access to the work of the photographic evidence panel and asked that the committee publish his comments on the panel's report.

The committee believes that Groden's views should be part of the record, although in including them, the committee or the panel do not endorse them. In addition, the committee noted some errors and misunderstandings in terms of the panel's work that should be borne in mind. By way of example, Groden was unaware that the frame of the Nix movie film corresponding to Zapruder frame 313, which shows the fatal head shot, had been digitally scanned, and that the photographic evidence panel had in fact been asked whether President Kennedy showed a reaction to a bullet prior to Zapruder frame 190. With respect to the work of the panel, Groden was also apparently unfamiliar with some procedures (that is, why only original materials were relied upon for enhancement and analytical purposes) and with the basis for some panel decisions (that is, why it attached little weight to the fact that the Kennedy autopsy photographs were taken with 1963 film). The general issues that Groden addresses in his comments, particularly in the area of the photographic evidence, are also addressed in the panel's report.

015086

January 3, 1979

The Honorable
Chairman Louis Stokes
Select Committee on Assassinations
U. S. House of Representatives
Washington, D. C. 20515

Dear Sir:

Enclosed please find the formal dissenting view dealing with the work of the Committee's scientific medical and photographic panels and my report on related photographic materials which I feel were inadequately covered in the public hearings.

As a photographic consultant to the Committee, I feel that these views should be expressed for the record and for history. I will be including photographic materials relating to the various reports herewith enclosed.

Sincerely,

Robert J. Groden

Robert J. Groden

I. THE "BACKYARD" PHOTOGRAPHS

Among the areas in which I disagree with the way the photo evidence was presented and treated, was using only Jack White's arguments in the area of the Neely Street photographs. You were all aware that some of the arguments presented were no longer issues and that some of them never really were. The true issues were not accurately dealt with in the hearings. These were the discrepancy of the head to body size as well as the height-to-rifle length ratio and the visual retouching of the skin and surrounding area. At the July 19 panel meeting I didn't argue the point because of my desire to attend the rest of the meetings. But in my opinion no matter what the panel members concluded, the backyard photographs are beyond question fakes. Disregarding all of the other evidence supporting the fact of forgery, the visual areas of retouching cannot be easily dismissed.

For the record, the method used here was, almost without doubt, simply posing a man (or possibly different men for each photograph) in the backyard with the rifle, pistol and publications as part of this original picture. The only item added was the head of Lee Oswald from the middle of the chin up. The argument that all of the backgrounds are the same is, I feel, impractical and the same goes for the idea of adding the shadows after the fact.

In spite of the fine work Jack White has done on the rifles, I don't believe using him alone to present "all of the issues" dealing with the Neely Street photographs can ever be justified.

II. The Nix and Moorman Pictures

Dr. Hunt's "analysis" of the Moorman No. 2 Polaroid photograph and the Nix film were in extreme error and the questioning insufficient to accurately deal with these items.

The best versions of the Moorman No. 2 Polaroid are the prints made from either of the original high resolution negatives in the possession of UPI and AP. Dr. Hunt didn't even see, scan, or study them. He used the original print which faded 15 years ago. You can hardly see the President in the foreground, and images in the background have long since nearly vanished including the "assassin" behind the retaining wall on the grassy knoll, the man behind the stockade fence and other shapes which raise questions as to others on the knoll. The man who appears in Willis No. 5 and the Zapruder film is clearly seen behind the wall in the Moorman No. 2.

Also overlooked is the fact of the Western-most wall edge changing shape depending on which negative was used to create any given specific point.

The first Moorman print on the other hand is not now as was originally described by all who saw it before the FBI confiscated it. It has now lost the sixth floor, which was there originally in the photograph as well as the eastern end of the TSBD and the "assassin's" window.

I intended to present evidence that as was the case with the Neely Street photographs, the Moorman pictures as they exist now are fakes. For instance, Mary Moorman took three consecutive photographs. The committee looked at the first and the third of the three and they both show evidence of retouching. None of this was dealt with by Dr. Hunt. Hunt couldn't see the man behind the wall because he no longer appears in the original print. His entire image has faded to white.

As for the Nix film, Hunt couldn't see a gunflash because the frame corresponding to Zapruder frame No. 312 was not scanned and is the only frame showing the flash. This is the frame just before the head explosion frame. It is doubtful that Dr. Hunt would even know where to look for the muzzle flash even if he had had the correct frame since we have had no interaction at all on this matter.

III. The Walker Bullet

The shot taken at General Walker was referred to several times during the public hearings as being fired by Oswald. This is a terribly misleading assumption.

It is still questionable whether the Mannlicher-Carcano can be linked to Oswald. But even if it was his, it could not have fired the "Walker bullet." Oswald's alleged rifle fired 6.5-mm ammunition, copper jacketed, while the Walker bullet was a steel jacketed 30.06.

Oswald has never been linked with another rifle during that period of time.

IV. Timing and Number of Shots

Although testimony given at the time of the public hearings would lead one to believe that it was the general consensus of the photographic panel that the timing and number of the shots had been established,

and that there was little question as to this conclusion, this was of course not the case. The vote was as presented split, but the ballot was not clearly defined. No one was asked if they thought a shot struck before Zapruder film frame number 190, nor were they asked if they felt shots struck both before and after the road sign.

One important result of that panel meeting was my discovery of a shot fired in the mid-to-late 150's of the Zapruder film.

Seven years ago, I discovered that President Kennedy was responding to a shot that missed by frame 158. But at the panel meeting I found that by frame 163, Governor Connally was also responding to the sound of the same shot. This coupled with the overall timing of the shot sequence of the police tape gives us a whole new perspective of the shot timing.

In the face of the current evidence it seems that this is the actual timing and firing order of the shots:

1. From behind. Missed. Fired in the 150's. Possibly hit the concrete by the manhole cover on the south curb of Elm Street, or the pavement on Elm Street. (There is Warren Commission testimony of this.)

2. From the front. Hit the President in the neck. Penetrated deep within the President's body and was removed during the autopsy by Commander Humes. (See FBI receipt for the bullet.) Struck the President between frames 188 and 189.

3. From behind. Struck the President in the back, 4 inches below the shoulder line to the depth of an inch or an inch and a half and did not traverse the body. This bullet probably fell out of the President's body either during the time the body was in Parkland Hospital or while enroute to Bethesda for the autopsy. Upon striking the President in the back, the transfer of momentum pushed the President forward and downward by several inches. This is one of the few occurrences on film that can be accurately measured but has gone totally overlooked by the photo panel. The hit occurs at frame 227, and the forward motion lasts for over a half dozen frames.

4. From behind. Hit Governor Connally in the back. There are two possible times for this hit. The first is at frame 227 when the Governor's right arm spins toward his left. The second occurs at frame 238 when there is a violent drop to the Governor's right shoulder and his cheeks puff out, his hair becomes disheveled. There is an outside possibility that these two pronounced movements may represent separate shots. The first to Connally's right wrist and the second to his back with either striking his left thigh.

V. Joseph Milteer

The matter of Joseph Adams Milteer is by no means put to rest by comparing the height of the man in the Altgens photo to Milteer's known height or the unknown relative heights of the other people in the crowd standing near him.

If the man in the crowd is Milteer it is just the icing on the cake. You have the Miami tapes as well as the Miami police reports and the FBI files on Milteer. He is strongly involved in both the Kennedy and King cases. He is proof of a conspiracy and that the FBI and

Warren Commission participated in an active collaborated coverup by burying all of the Milteer evidence in the National Archives and never mentioning his name even once in the Warren Report or the 26 volumes of evidence. Milteer is a prime suspect in both the John Kennedy and Martin Luther King murder plots.

Resting the Milteer case on the height of the crowd man would be a gross error in judgment.

VI. The Acoustics Tests

There seems to be a problem in the way the acoustics tests were done:

1. Only two firing points were considered for acoustical matching—the "Oswald window" and behind the stockade fence. By using the audio signals and echo patterns from only these two points, the testing machinery could eliminate any other shot, echo pattern or sound below the dB threshold used, related to shots from behind the retaining wall, the southern knoll, the Dal-Tex building, the Records building, other depository window or the roof, or any other possible firing point from its final conclusions thereby destroying the use or value of the tests.
2. By not removing the new overhead road signs and replacing the old Stemmons Freeway sign, new elements are introduced that will alter the results of the tests and eliminate from consideration possible shot sounds and echo patterns altered by these new elements.
3. Different ammunition was used in the testing. First, older ammunition of the type allegedly used by Oswald was used. Then, newer ammunition was used that gave a different sound even audibly to the witnesses and the testing machinery is far more sensitive than the human ear to such changes.

In spite of the many inconsistencies in the testing procedure, there was still evidence of a possible four shots from at least two different directions.

It must be noted here that the first acoustical tests done on the Dallas police tape found very strong evidence of at least seven shots which is confirmed by the visual and concrete evidence at the time of the assassination.

VII. Report on Issues Relating to the Authenticity of the Autopsy X-Rays and Photographs of President John F. Kennedy

During the public hearings in September, witnesses from the committee's scientific panels stated that in their opinion the autopsy photographs and X-rays of President Kennedy were genuine, citing such evidence as the fact that the film used was produced in 1963.

The importance of the photographs and X-rays cannot be overestimated. Every scientific panel—photographic, medical, acoustics, ballistics, N.A.A., et cetera—all depend upon the autopsy materials for their testing and conclusions.

The basic conclusions from all except the acoustics panel is that two shots struck the President from behind.

On the surface it would seem that the autopsy materials bear out this conclusion. That, however, may not be the case.

There is evidence that raises grave questions about the authenticity of the items being relied upon by the select committee and its panels. Moreover, there is medical data in the photos and X-rays which is apparently being ignored.

1. THE PROBLEM OF AUTHENTICITY

The fact that the HSCA panels have been unable to establish inauthenticity of these items may not reflect their authenticity but rather the skill with which they were forged.

In considering the matter of authenticity of some of the autopsy photographs, my main concern is that of the large head exit wound and its exact and general location as described by the vast majority of trained medical personnel at Parkland Hospital and reported by many of the Dallas witnesses. The main issue here is that such a wound may have been photographically eradicated from the only visual record of the President's body following the assassination via the simple technique of photo-compositing. If done with care, this would be undetectable.

On this point, some of the photo panel's tests would be meaningless. For example, one test the panel claims proves authenticity is that the film in evidence was manufactured in 1963. It seems that if any one were to plot the forging of these pictures that they would not wait until the film used in the other (genuine) autopsy photographs would be out of date, and that they would certainly use the same film that would have been originally used in the entire autopsy series. All this test proves is that the forgeries could have been produced in late 1963 or early 1964.

For the record, my visual inspection of the autopsy photographs and X-rays reveals evidence of forgery in four of the photographs: Color chromes No. 42 and No. 43 showing the rear of the head and No. 15 and No. 16 which appear to be the same shots in black and white (made from black and white duplicate negatives of No. 42 and No. 43).

Within the circumference of the President's head, there is an irregular line. Within this line the hair appears black and wet. On the outside of the line it is auburn and completely dry. In later generations of these photographs, a large degree of contrast buildup becomes apparent at the line's edge and the line becomes clearly defined. This phenomenon is characteristic of crop lines in matte insert processes used for retouching and recompositioning of photographs.

It is my opinion that these two photographs are forgeries, composites manufactured to eliminate evidence of an exit wound in the rear of the President's head. The only method I am aware of that could have been used to create these composites is known as "soft edge matte insertion." (See attachment 1.)

The question of the authenticity of these particular photographs is crucial because of the large volume of evidence indicating that at least one shot struck the President in the head from the front, causing an exit wound at the rear of the skull. The problem is that this wound, seen by so many in Dallas, does not appear in the autopsy photographs and X-rays.

The most reliable descriptions were those from the Parkland doctors on the day of the murder. Doctors Clark, Jones, Perry, Baxter, Akin,

McClelland, and Nurses Hutton, Bowron, and several others all describe that same wound in great detail, and all place it at the same point in the rear of the President's head in the area of the occipital bone. Many said cerebellar tissue protruded from a large avulsive exit wound. This too indicates a lower rear head exit wound. A partial list of the many eyewitnesses who describe this wound is included as attachment 2 to this memo. It seems highly improbable that all these witnesses were mistaken.

Furthermore, the descriptions of the eyewitnesses who saw Kennedy's head wound at Parkland are corroborated by those who saw the bullet impact upon the head in Dealey Plaza.

Secret Service Agent Clint Hill saw a piece of the President's skull fly from the President's head and travel toward the rear-left of the car. Mrs. Kennedy attempted to pick up this piece (and indeed from a recently declassified portion of her Warren Commission testimony we can see that she may have picked up a section of skull) and tried to hold it onto the rear of her husband's head.

The next day Billy Harper found a piece of bone in Dealey Plaza. Originally, the "Harper" fragment was identified by a qualified pathologist as a section of occipital bone.

In addition, there is photographic evidence of a shot exiting from the rear of the President's head.

Zapruder film frames No. 335 and No. 337 clearly show the result of the head shot. They are the clearest two frames showing the President after the head explosion.

I have examined and measured the contours of the President's head on Zapruder film frames 335 and 337. The rear of the President's head, in these frames, shows his hair pushed upward and away from the scalp. That indicates the bones underneath were avulsed outward. This matches the description of the wound provided by Dr. McClelland who said the bones at the rear of the head were "sprung open." (See attachment 2 for full quote and other descriptions of this wound.)

Conclusions

The Dallas observations indicating a rear exit hole cannot be easily dismissed. These accounts were provided by trained medical personnel. It defies belief that so many people, viewing the President from different angles at different times, should all describe the same wound condition and position. My own examination of the autopsy photographs of the rear of the head shows a sharp contrast buildup along an irregular line at the rear of President Kennedy's head. This contrast buildup could be the result of a photocompositing process whereby another photograph was superimposed on the back of President Kennedy's head, thus eliminating evidence of that exit wound. Based upon my observation of that contrast buildup, and the Dallas medical observations indicating there was a wound there, it is my opinion, as a photo-consultant to the House select committee, that these photographs are forgeries.

2. LEFT TEMPORAL WOUND

There are at least two Parkland Hospital doctors who noted a wound of entry in the President's left temple. (Dr. Robert N. McClelland and Dr. Marion T. Jenkins)

Dr. McClelland, in his official statement regarding the assassination filled out at 4:45 p.m. on November 22, wrote: "The cause of death was due to massive head and brain injury from a gunshot wound of the left temple." (WR, p. 527) Dr. Jenkins, in his testimony to the Warren Commission on March 25, 1964, stated that "* * * I thought there was a wound on the left temporal area, right in the hairline and right above the zygomatic process." (H6, p. 48) When informed that no one else had noted such an entrance wound, Dr. Jenkins stated that it might have been blood from some other point.

My examination of this area on autopsy photograph No. 29 leads me to believe that Dr. Jenkins was correct on his initial opinion.

Close inspection of the left temporal area on the original transparency (but not on any of the later generation duplicates) reveals the presence of a faint but distinct circular hole which I estimate to be approximately 5 or 6 mm in size in the left sideburn approximately 25 to 30 mm above the bottom of the sideburn, and 10 to 15 mm in front of the foremost ear line. (Photos 30 and 31 show much the same area but because of different exposure and clarity of the film, the hole shape is not as evident.)

The other photographic and medical panel members who inspected the autopsy items were not familiar with the Kennedy case and the question of a left temporal wound prior to and at the time of their examination of these items and so were probably not looking in that area for any damage.

I must point out that on transparency No. 29, the "hole" is visibly very faint with no blood to highlight it to the casual observer. Indeed, if one did not know to look for evidence of this wound, it would simply remain unnoticed.

To facilitate future study, I have made a single 8 x 10 glossy print of this area which is at the Archives stored with the original collection. (I made two such photographs: One was not clear because the transparency moved while in the enlarger.)

On July 19, 1978, while Dr. Michael Baden was at the Archives examining the X-rays and photographs, and I was attending a meeting of the photo panel, I telephoned Dr. Baden and informed him of the existence of this evidence of a left temporal bullet wound. While still on the telephone with me, Dr. Baden examined the photographs. He said he could locate no wound in the left temple, and that what I was seeing was "a small spot of blood." From this conversation, I could have concluded that either: (*a*) Dr. Baden was looking at a blood spot at another point close to the "hole"; or (*b*) Baden and I both saw the same thing in the left temporal area, but simply disagree as to what it meant.

On October 27 I had another opportunity to examine the X-rays and photographs and, on that occasion, I noted again that there was no blood visually related to this wound, raising further question of Dr. Baden's diagnosis. At that time I also discovered that the skull X-rays contained data which seem to indicate a hole in the left temple.

On lateral X-rays of the skull, there is a gray spot at the same location as the "hole" on photo No. 29. There is, however, no evidence of radiating fracture marks on the skull from this point.

Conclusion

There is photographic and X-ray evidence supporting the observations of the Dallas doctors—McClelland and Jenkins—that there was a left temporal entrance wound.

I feel it is the committee's obligation to have the medical panel reexamine the X-rays and photographs, in the area I have pinpointed, and, if they disagree with my conclusion, explain what this circle represents, if not a bullet hole, and also explain the corresponding image on the X-rays.

VIII. Recovered Bullet During JFK Autopsy

Although there is a great deal of evidence that a bullet was recovered from President Kennedy's body at the time of the autopsy, none of the evidence of this bullet was ever mentioned in the public hearings.

To recap, Warren Commission document No. 371 reveals "one receipt from the FBI for a missile removed during the examination of the body." An examination of the receipt shows that a bullet was removed from the body of President Kennedy during the autopsy in the evening of November 22, 1963. This bullet was handed over to and signed for by FBI agents Francis X. O'Neill and James W. Sibert.

The January 4, 1964, issue of the Journal of the American Medical Association (vol. 187 No. 1) stated on page 15 that the bullet was recovered during the autopsy.

The Washington Post of December 18, 1963, after checking the report with the FBI before publication, stated that a bullet was recovered from deep within the President's shoulder. This was again confirmed in the Post on May 29, 1966.

The fact of the recovery of this bullet fully destroys the myth of the "single bullet," and that evidence of an additional gunshot during the assassination was suppressed.

Commander Humes removed this bullet but there is no indication from which direction the bullet came. If it was from the front, there had to be at least two assassins. If the bullet came from behind and as the best evidence will show, did not exit the President's body, considering the number and timing of the shots in any combination, there had to be more than one assassin.

The issue has been raised that the bullet or missile may have been a fragment of a bullet or missile. This seems highly unlikely since Sibert and O'Neill were professional enough to know the difference between an entire bullet and a small fragment. In addition to this, the FBI itself did confirm to the Washington Post that it was "a bullet" and not just a fragment.

It should be noted that this entire area of discussion occurred many months before the single bullet theory was invented to try to prove the "lone assassin theory."

Attachment 1: Soft Edge Matte Insertion

Given the present nature of these photographs, the only method that I am aware of that could have been used to alter them is called soft edge matte insertion.

The technique uses a black and white masking process and this is how it works:

An original 4 x 5 photograph; that is, transparency would be taken showing the rear of JFK's head with the exit wound in the center (in this case two, No. 42 and No. 43). Using one at a time, it is pin registered and placed in a photographic enlarger along with a pin registered piece of 4 x 5 black and white film called a registered black core matte. This is clear film with a black center in a specific area over the area on the original transparency to be eliminated. The clear fades quickly to the black, not a sharply defined edge, hence the term "soft edge."

This "sandwich" is then projected onto another piece of 4 x 5 Ektrachrome transparency film. In this case the result so far would be the rear of the President's head with a large blank, black area in the rear. This new piece of film is then put in a light tight container.

At this point, another transparency of the back of another head, this one with an entrance bullet hole and hair that matches J.F.K.'s head photographed to the same size, is pin registered with a clear core matte which is a piece of black film tapering to a clear center. This is a contact film print of the black core matte and fits exactly in register with the original transparency and the black core matte.

This new "sandwich" is then projected in register onto the partially exposed Ektachrome. Now the photograph is complete.

The final result is what appears to be the rear of the President's head with a small wound of entry near the top. The same thing is done to the other original in register and the result is a pair of virtually undetectable forgeries of the finest possible quality. The technique would allow the integrity of stereo views.

Attachment 2: References to an Occipital Head Wound of Exit in Warren Report (Part of CE 392, Appendix VIII, pp. 516–530)

Kemp Clark—"Two external wounds, one in the lower third of the anterior neck, the other in the occipital region of the skull, were noted." (p. 517) "There was a large wound in the right occipito-parietal region * * * both cerebral and cerebellar tissue were extruding from the wound" (p. 518).

Charles Carrico—"Dr. Jenkins attempted to control slow oozing from cerebral and cerebellar tissue via pads instituted" (p. 520).

Malcolm Perry—"A large wound of the right posterior cranium was noted * * *" (p. 521).

Charles Baxter—"* * * the right temporal and occipital bones were missing and the brain was lying on the table * * * (p. 523).

Kemp Clark (handwritten at 4:15 p.m.)—"There was a large wound beginning in the right occipital extending into the parietal region" (p. 525).

M. T. Jenkins—"There was a great laceration on the right side of the head (temporal and occipital) causing a great defect in the skill plate * * * even to the extent that the cerebellum had protruded from the wound" (p. 530).

Dr. John Ebersole (taped interview with Gil Delaney, Lancaster Intelligencer-Journal) + (a.), March 8, 1978—"knew shot came

from the back or side because the back of his head was blown off." (Ebersole now says he was misquoted.)

In an interview with Art Smith, Chester, Pa., Ebersole said the back of the skull was intact "except for maybe three small fragments."

Dr. Ronald Jones—"What appeared to be an exit wound in the posterior portion of skull" (6H56).

Dr. Perry—"A large avulsive injury of the right occipital area (6H11).

Dr. Charles Baxter—"A large gaping wound in the back of the skull * * * literally the right side of his head was blown off" (6H 40–41).

Dr. McClelland—"As I took the position at the head of the table * * * I was in such a position that I could very closely examine the head wound, and I noted that the right posterior portion of the skull had been blasted. It had been shattered apparently, by the force of the shot so that the parietal bone was protruded up through the scalp and seemed to be fractured almost along its posterior half, as well as some of the occipital bone being fractured in its lateral half, and this sprung open the bones that I mentioned in such a way that you could actually look down into the skull cavity itself and see that probably a third or so, at least, of the brain tissue, posterior cerebral tissue and some of the cerebellar tissue had been blasted out" (6H33).

Nurse Pat Hutton—"Pressure bandage was no use * * * because of the massive opening on the back of the head."

Dr. Gene Akins—"Back of the right occipital parietal portion of his head was shattered, with brain substance protruding" (6H65).

Dr. Clark—"* * * examined the wound in the back of the President's head. This was a large, gaping wound in the right posterior part, with cerebral and cerebellar tissue being damaged and exposed" (6H20).

Dr. Peters—"We saw the wound of entry in the throat and noted the large occipital wound" (6H71).

Diana Bowron—Parkland Hospital nurse.

[Warren Commission testimony follows:]

BOWRON, DIANA - TESTIMONY before Warren Commission

These are some of the most relevant excerpts from the testimony of Parkland hospital nurse Diana Bowron who was the first trained medical person to observe the President upon arrival at Parkland hospital and observed the President face down in the car. She looked directly at the wound of exit in the rear of the President's head.

TESTIMONY OF DIANA HAMILTON BOWRON

The testimony of Diana Hamilton Bowron was taken at 2:05 p.m., on March 24, 1964, at Parkland Memorial Hospital, Dallas, Tex., by Mr. Arlen Specter, assistant counsel of the President's Commission.

Mr. SPECTER. And what, in a general way, did you observe with respect to President Kennedy's condition?

Miss BOWRON. He was moribund—he was lying across Mrs. Kennedy's knee and there seemed to be blood everywhere. When I went around to the other side of the car I saw the condition of his head.

Mr. SPECTER. You saw the condition of his what?

Miss BOWRON. The back of his head.

Mr. SPECTER. And what was that condition?

Miss BOWRON. Well, it was very bad—you know.

Mr. SPECTER. How many holes did you see?

Miss BOWRON. I just saw one large hole.

Mr. SPECTER. Did you see a small bullet hole beneath that one large hole?

Miss BOWRON. No, sir.

Mr. SPECTER. Did you notice any other wound on the President's body?

Miss BOWRON. No, sir.

Mr. SPECTER. And what action did you take at that time, if any?

Miss BOWRON. I helped to lift his head and Mrs. Kennedy pushed me away and lifted his head herself onto the cart and so I went around back to the cart and walked off with it. We ran on with it to the trauma room and she ran beside us.

And an excerpt from a newspaper article labled as "Bowron exhibit No. 3. in Warren Commission volume #19.

Diana, who was trained at Hope Hospital, Salford, said: "I realised who the man in the car was as soon as I saw Jackie Kennedy. Mr. Kennedy was slumped forward in his seat—and so was Mr. Connally.

Robert J. Groden

Robert J. Groden
Photo Consultant, H.S.C.A.

ATTACHMENT 3: SUSPECTED FIRING POINTS IN THE ASSASSINATION OF PRESIDENT JOHN F. KENNEDY, AS THEY RELATE TO THE PHOTOGRAPHIC EVIDENCE

There are nearly 2 dozen suspected firing points in Dealey Plaza that have been raised by Warren report critics through the years. Of these, several are worthy of close inspection for they may be candidates as probable sources of shots within the plaza. Some of the 2 dozen:

1. The TSBD easternmost sixth floor window facing south (the "Oswald" window).
2. The TSBD roof.
3. The TSBD seventh floor.
4. The TSBD fourth floor, third pair from the left (west) end.
5. The TSBD westernmost pair of sixth floor windows facing south.
6. The Dal-Tex building second floor.
7. The Dal-Tex building third floor.
8. The Dal-Tex building upper floor (any of the top three).
9. Dal-Tex roof.
10. The county records building roof.
11. The county records building second floor.
12. The stockade fence on top of the "grassy knoll".
13. The cement retaining wall in front of the stockade fence.
14. In front of the cement structure on the knoll at the end of the stockade fence (northeastern end).
15. The railroad overpass.
16. A storm drain at the north curb of Elm Street.
17. The "umbrella man".
18. The "south knoll" (the grassy knoll on the south side of the plaza on Commerce Street).

Nos. 1 thru 11 were to the President's rear, 12 thru 16 were to his right front, 17 started at the front and ended to the rear as the car passed by, and 18 was to the President's left front.

1. Was almost certainly a firing point. If the "Oswald" window was used during the assassination, whether by Lee Oswald or any one else (this remains to be proven), it is logical to assume that there would be from this window. This would be consistent with a prearranged scenario as well with the official version of the crime. The film taken by Charlse Bronson may show a dummy snipers nest for a cover story being constructed just 7 minutes before the shots were fired.

2. and 3. are possible alternatives to 1 but with far less opportunity for interruption by a bystander as was always a possibility at the "Oswald" window. There were reports of a rifle being found at 2 and 3 was not even searched.

4. Is considered by Dr. Cyril Wecht because of the angle of bullet trajectory from that point.

5. Is the point where witness Arnold Rowland saw two men with a rifle just before the assassination but thought that they were Secret Service agents. There was also what appeared to be a bullet mark on the north sidewalk of Elm Street (since removed) that lined up with this window.

6. Because of a photograph taken by A.P. photographer, James Altgens, seeming to show a rifle shaped object protruding from the second floor window of the Dal-Tex building, several Warren report critics (including myself) felt that this was probably a firing point for one or two of the shots. The committee has made available to me the original Altgens negative. Using my technique of vario-density eynexing, I was able to enhance the image in the window to the point of clarity where the figure in the window is now identifiable as a black man leaning on the window sill with both hands, and with no gun in view.

7. Has been charged as a firing point for the same reason as window 6. Using the VDC technique. I feel that the window was closed and I can find no evidence of any shots from that window.

8., 9. and 10. are strong interchangeable possibilities for one or two of the shots from the rear. Either President Kennedy's or Governor Connally's back wounds or the President's rear entering head wound. These angles are much closer to the alleged trajectory (rear to front) than the depository points 1 to 5.

11. Only one man, Hugh McDonald, has mentioned this as a firing point. Logistically, it simply could not have been. The angles and line of sight won't line up to any traceable shot.

12. The committee's acoustic panel has presented corroborative evidence to support the photographic evidence that this was in fact a firing point. A figure can be seen in both the second Moorman Polaroid photograph (clearly showing a figure in the area directly behind the stockade fence, 8 feet to the left of the corner of the fence), and the closing few dozen frames of the Zapruder film also seem to show a figure in the same spot. Independently, the sound tapes from the stuck transmitter place a firing point in this exact position, as do a great deal of eye and ear witnesses to the shooting.

13. Appears in a long list of films and photographs: (*a*) the fifth Phil Willis slide; (*b*) the Hugh Betzner photo corresponding to Willis No. 5; (*c*) the Abraham Zapruder film frames in the area surrounding and including No. 413; (*d*) the Orville Nix film in shadow near the left edge of the retaining wall; and (*e*) the Marie Muchmore film for one frame at the extreme top of the frame.

After the shooting, a large crowd of spectators chased this man, who some thought was a gunman, back into the parking lot where he disappeared, and where a man with false Secret Service identification was encountered. In items a and c, a shape appearing to be a weapon or rifle-shaped object is noted being held by this man. The HSCA photo panel has determined that this is indeed a human shape.

14. Appears in the Orville Nix film for an entire sequence and can be seen in motion. Stereo pairs show this shape to have three dimensions, and to be in the plaza in front of the concrete structure with the "left arm" portion extending beyond the edge of the wall. There are similar patches of light and shadow visible on the wall in the next sequence that give the impression that this shape was only shadows. It was not. These remaining shadows lack the coloring and texture of the image itself.

15. There is no photographic evidence of an assassin at this point.

16. There is no photographic evidence of an assassin at this point.

17. It seems unlikely that a shot could have come from this point.

18. Two Dallas doctors noted an entrance wound in the President's left temple. I have also noted in autopsy photograph No. 29 and the front view X-ray that there seems to be such a bullet wound in evidence. If there was, then this probably came from the area of the southern grassy knoll. The only photographic evidence of a shot from this point is the Cancellare photograph. It shows a shape that appears to be a man holding what appears to be a rifle on top of the knoll near a tree just seconds after the shots were fired. However, this shape is far too vague to be considered proof of a gunman and must be considered with its limitations.

It is my opinion that Nos. 1, 9, 10, 12, 13, and 18 are the most likely candidates for firing points as well as either 2, 3, 4, 5, or 8 (one of these).

It is also my opinion that only four of the above or at the most five are truly candidates for firing points and that No. 14 was a probability who never fired a shot. The rest on the list I cannot believe to be points where shots came from on the basis of photographic evidence as well as other physical evidence.

Attachment 4: Memo—Robert J. Groden to Jane Downey Subject—The Charles Bronson Film

February 25, 1979.

Earlier this year, I inspected and optically enhanced the regular 8-mm color motion picture of the assassination of President John F. Kennedy taken by Mr. Charles Bronson. There are four scenes of importance in this film:

1. Before the motorcade arrived, approximately 7 minutes before the shooting.
2. The motorcade on Main Street.
3. The motorcade on Houston Street.
4. The motorcade on Elm Street showing the President at the moment of the head explosion.

During the moments before the President arrived in Dealey Plaza, a bystander experienced an "epileptic seizure" and an ambulance was summoned. While the ambulance was present on Houston Street, Mr. Bronson filmed 8 seconds of footage from his position at the southwest corner of the Main-Houston intersection. He was standing on a pedestal near the corner, and his camera was running at 12 frames per second to preserve film (instead of the usual 18 fps).

At the upper left corner of the film frame for this entire sequence, Mr. Bronson photographed the two easternmost pairs of windows of the sixth floor of the Texas School Book Depository, including the window that Lee Oswald was supposed to be in at that moment.

Close inspection and optical enhancement reveals definite movement in at least two and probably three of the windows in question. The two most obvious are the same two windows (Nos. 1 and 3) that show movement in the Robert Hughes film at the beginning of the actual firing sequence. Also, the Hughes and Bronson films both show the man in window No. 1 to be wearing a bright reddish shirt (or so it appears) and the man in window No. 3 to be wearing a neutral-colored shirt.

The man in window No. 1 is moving rapidly back and forth, and the man in No. 3 seems to be crouched down at the window and rocking on his toes in much the manner of a baseball catcher.

The shape in window No. 2 is slightly less distinct than the other two. I originally felt that this "man" was actually the man in window No. 1 leaning back and forth, probably moving boxes around to construct what would later be called "the sniper's nest."

I now feel that this is a distinctly different person who is probably handing boxes to man No. 1.

As you know, I was sorry to hear the wording of the representative of the photo panel who testified that the moving shapes in these windows could not be identified as human one way or another from the Hughes' film. The fact that the shapes are indeed moving and stereo views show them to be well within the windows but not in as far as the boxes in the background, and that there is nothing else that these shapes could possibly be except human movement, should at least have prompted the wording to allow for a fairer comprehension on the part of another party concerned with the issue at a later date as is now the case of the Bronson film. When the subject was first raised as to the men in the windows, the press quoted the panel as stating that the Hughes film showed no one in the windows. This was not the case. So I would suggest the wording in any analysis of the Bronson film to be more exacting.

I am delighted to learn of the computer work that Mr. John Sigalos, the attorney for Mr. Bronson is going to have done independently, and I suggest another look at the Hughes' film.

ATTACHMENT 5: MEMO—ROBERT J. GRODEN TO JANE DOWNEY

SUBJECT—THE DILLARD NEGATIVES

FEBRUARY 25, 1979.

I have just examined the two Dillard negatives showing the so-called "Oswald" window. I am sorry to report that the negatives are both severely damaged, but in different ways.

Negative No. 8, which is the more familiar of the two, and is a wide-angle photograph, appears to be coated on its emulsion side with a coating of some type. It is possible that what this is is the emulsion itself in a badly damaged condition perhaps as a result of the radioactive testing done for the committee.

The image on the negative is also in very poor condition, and appears to show the effects of a phenomenon called reticulation. This looks like small horizontal and vertical lines running throughout the image area and extending into the marginal area surrounding the picture area itself.

I cannot determine for sure whether the crosshatching occurs in the emulsion itself or if it is on the coating (if indeed the "coating" is a foreign addition to the negative and not just damaged emulsion).

Negative No. 24 also has this problem but in addition, the negative has an area where the emulsion has been rubbed off of the base. It appears that the negative was subjected to an intensely hot liquid and rubbed to remove the radioactive coating which was applied for the analytical work done for the committee. It seems that at this time,

the wet emulsion was actually smeared by an outside force, for an area of the image has been removed from the base. It is my opinion that this damage is irreversible.

I would also like to point out the appearance of what seems to be a human figure at the extreme western window on the sixth floor of the TSBD in negative No. 8. Negatives No. 8 and No. 24 were exposed at about the same time but from two different cameras (No. 8 with a wide-angle lens and No. 24 with a telephoto lens). I would estimate that both of these photographs were exposed within 10 seconds of the last gunshots, and if the figure in the western end window is a human figure (where eyewitness Arnold Rowland saw a human figure standing) we have more proof of a larger conspiracy.

If your computer enhanced negative(s) show this area, I strongly suggest inspecting this area from it/them.

Due to the deterioration of the original negative, I cannot be sure as to what this figure is. If the computer duplicate negatives are better, it would definitely be worth examining them to study the shape.

As for the "Oswald" window, I can see no human figure in either negative.

Attachment 6: The Altgens Doorway Man Issue

The main items used by me in determining the true identity of the man in the TSBD doorway in the fifth Altgens photograph were:

The John Martin film original.—This camera original, when viewed under the correct lighting conditions, shows that the degree of facial growth on Billy Lovelady was not as great as it originally appeared in the DCA release prints;

The Robert Hughes film original.—This color film shows the color of the shirt that Mr. Lovelady is wearing. The colors seem to be consistent with the shirt worn by Mr. Lovelady in the Martin film (above);

The Mark Bell film original.—This film was taken at a closer range than the Hughes film and was taken at the same time. It clearly shows the color and pattern of the shirt worn by the doorway man. It is consistent with the shirt worn by Mr. Lovelady; and

The James Altgens negative original.—The photograph that started it all is the best evidence as to the identity of the man pictured in the doorway of the TSBD. The pattern of light and dark plaid is heightened through the technique of vario-density cynexing directly onto Kodak 5302 fine grain release positive to give a full range of contrast and density results for careful high magnification study. Using this process, which I developed several years ago for this purpose, it can be seen, even by a layman, that the pattern is indeed that of Mr. Lovelady. This technique yields images perhaps two to four times clearer than conventional photographic methods.

Robert J. Groden,
Photographic consultant, HSCA.

REFERENCES

(*1*) Richard Sprague, "The Assassination of President John F. Kennedy: The Application of Computers to the Photographic Evidence," Computers and Automation, May 1970, p. 34.

(*2*) See, for example, Mark Lane, "Rush to Judgment," (New York: Dell Publishing Co., 1976), pp. 344–356; Sylvia Meagher, "Accessories After the Fact" (New York: Vintage Books, 1976), pp. 3–35; F. Peter Model and Robert J. Groden, "JFK: The Case for Conspiracy" (New York: Manor Books, Inc., 1977), pp. 124–165, 186–189; J. Gary Shaw, "Cover-Up: The Governmental Conspiracy To Conceal the Facts About the Public Execution of John Kennedy" (published by the author, 1976), pp. 32–39; Richard Sprague, See ref., 1, pp. 29–60; Josiah Thompson, "Six Seconds in Dallas" (New York: Bernard Geis Associates, 1967); Harold Weisberg, "Whitewash II: The FBI-Secret Service Cover-Up" (published by the author 1967), pp. 128–249; Harold Weisberg, "Photographic Whitewash: Suppressed Kennedy Assassination Pictures" (published by the author 1967).

(*3*) J. C. Dainty and R. Shaw, "Image Science" (New York: Academic Press, 1976), pp. 116–150.

(*4*) See, for example, Harry Andrews and Bob R. Hunt, "Digital Image Restoration" Englewood, N.J.: Prentice-Hall, Inc., 1977).

(*5*) C. Mees, "The Theory of the Photographic Process" (New York: McMillan Co., 1954).

(*6*) See ref. 3, Dainty and Shaw, p. 48.

(*7*) Bob R. Hunt, "Digital Image Processing," IEEE Proceedings, vol. 63 (Apr. 1975), pp. 693–708.

(*8*) A. Oppenheim and R. Schafer, Digital Signal Processing, (Englwood, N.J.: Prentice-Hall, Inc., 1975).

(*9*) See ref. 4, Andrews and Hunt, pp. 61–89.

(*10*) J. Goodman, Introduction to Fourier Optics (New York: McGraw-Hill, 1968).

(*11*) Research Proposal, "Autoradiographic Intensification of Photographic Evidence," prepared for the House Select Committee on Assassinations, by Stanford Research Institute International, Mar. 3, 1978 (J. F. K. Document No. 006309).

(*12*) Report of the President's Commission on the Assassination of President Kennedy (Washington, D.C.: U.S. Government Printing Office, 1964), p. 19 (hereinafter cited as the Warren report).

(*13*) Ibid.

(*14*) Ibid, p. 111.

(*15*) Ibid., p. 115.

(*16*) Ibid.

(*17*) Ibid., p. 117.

(*18*) Ibid., p. 106.

(*19*) Ibid.

(*20*) See ref. 2, Model and Groden, pp. 124–157, and Thompson, pp. 59–79.

(*21*) Ibid.: see also Lane, ref. 2, pp. 69–80, and Meagher, pp. 27–35.

(*22*) See ref. 2, Thompson, pp. 216–18.

(*23*) Testimony of Lyndal L. Shaneyfelt, May 6, 1964. Hearings before the President's Commission on the Assassination of President Kennedy (Washington, D.C.: U.S. Government Printing Office, 1964), vol. 5, p. 153 (hereinafter 5 Warren Commission Hearings, 153).

(*24*) Testimony of Gov. John Connally, April 2, 1964—Warren Commission Hearings, pp. 132–33.

(*25*) See ref. 23, Testimony of Lyndal L. Shaneyfelt, p. 153.

(*26*) Scientific Report of the Kennedy Assassination Forensic Pathology Panel, Appendix to the hearings before the Select Committee on Assassinations, U.S. House of Representatives, 95th Congress, 2nd session (Washington, D.C.: U.S. Government Printing Office, 1979), vol. VII, pars. 294–343 (hereinafter J. F.

K. Forsenic Pathology Panel Report, HSCA–JFK Hearings, VII) ; see also pars. 127–141 of this report, the Photographic Evidence Panel Report.

(27) See fig. II–10 (J. F. K. exhibit F–133).

(28) Scientific Report of the Kennedy Assassination Firearms Panel, Appendix to the hearings before the Select Committee on Assassinations, U.S. House of Representatives, 95th Congress, 2nd session (Washington, D.C.: U.S. Government Printing Office, 1979), vol. VII, (hereinafter J. F. K. Firearms Panel Report VII, HSCA–J. F. K. hearings).

(29) An Analysis of Recorded Sounds Relating to the Assassination of President John F. Kennedy, a report prepared for the House Select Committee on Assassinations, by Mark R. Weiss and Ernest Aschkenasy, February 1979, vol. VIII, sec. 4.2.3 (hereinafter Weiss and Aschkenasy report).

(30) See pp. 69–70 of this report of the Photographic Evidence Panel.

(31) C. Landis and W. Hunt, the Startle Reaction (New York: Holt Rhinehart, 1939).

(32) Ibid.

(33) See fig. II–10 (J. F. K. Exhibit No. F–133).

(34) See para. 69–70, of this Report of the Photographic Evidence Panel.

(35) Warren Report, pp. 49–50; testimony of Mr. and Mrs. John B. Connally, Sept. 6, 1978, I HSCA–J. F. K. hearings, p. 42.

(36) Analysis of Recorded Sounds Relating to the Assassination of President John F. Kennedy, Report No. 3947, prepared for the House Select Committee on Assassinations by Bolt, Beranek & Newman, Inc., January 1979 (hereinafter Bolt Beranek & Newman Report No. 3947).

(37) Report of the Select Committee on Assassinations: Findings and Recommendations, U.S. House of Representatives, 95th Congress, 2nd session (Washington, D.C.: U.S. Government Printing Office, 1979), Section IA1 (hereinafter SCA report).

(38) Bolt Beranek & Newman Report No. 3947, table II, pp. 61, 75.

(39) Ibid., p. 33.

(40) The Harper Encyclopedia of Science (New York: Harper & Row, 1963), Vol. 4, p. 1196.

(41) Encyclopedia Britannica (Chicago: Wm. Benton Publishers, 1970), p. 533.

(42) Ibid.

(43) Photogrammetric Analysis of Zapruder and Nix Movie Film, a report prepared for the House Select Committee on Assassinations by the U.S. Geological Survey, November 1978 (hereinafter USGS Report) (J. F. K. Document No. 013633).

(44) Warren Report, pp. 92–117.

(45) See ref. 26, J. F. K. Forensic Pathology Panel Report, para. 294–304.

(46) See ref. 43, USGS Report.

(47) See ref. 26, J. F. K. Forensic Pathology Panel Report, para. 236–67.

(48) Memorandum of G. Robert Blakey, Feb. 22, 1979, V House Select Committee on Assassinations—J. F. K. hearings, 723.

(49) See para. 97–98, of this report of the Photographic Evidence Panel.

(50) Ibid., para. 69–70.

(51) Zapruder Film Analysis, a report prepared for the House Select Committee on Assassinations by Frank Scott, Aug. 15, 1978 (J. F. K. Document No. 014709).

(52) Outside Contact Report with Robert Croft, Sept. 11, 1978, House Select Committee on Assassinations, (J. F. K. Document 012578).

(53) See ref. 51, Scott Report.

(54) "Displacement of Cutaneous Landmarks of Anterior Neck with Head Rotation and Extension," a report prepared for the House Committee on Assassinations by the FAA Civil Aeromedical Institute, July 14, 1978 (J. F. K. Document No. 013002).

(55) Ibid.

(56) See ref. 43, USGS Report.

(57) Memorandum from Dr. Michael Baden to the House Select Committee on Assassinations, Sept. 8, 1978 (J. F. K. Document No. 011372).

(58) Limousine drawing dimensioned from the original body draft by manufacturer Hess & Eisenhardt, July 24, 1978 (J. F. K. Document No. 010113).

(59) See ref. 26, J. F. K. Forensic Pathology Panel report, paras. 272–289.

(60) See ref. 36 Bolt Beranek & Newman Report No. 3947.

(61) Ibid; see paras. 108–109, of this report of the Photographic Evidence Panel.

(*62*) Ibid.
(*63*) Ibid.
(*64*) See ref. 37, House Select Committee on Assassinations report.
(*65*) "Warren Report," p. 19.
(*66*) Ibid., pp. 122–129.
(*67*) Testimony of Jack D. White, Sept. 14, 1978, II House Select Committee on Assassinations—J. F. K. Hearings, 341–344; letter and photographic analysis comments from Fred Newcomb to the House Select Committee on Assassinations, Mar. 7, 1977 (J. F. K. Document No. 00913).
(*68*) F. Jenkins and H. White, "Fundamentals of Optics" (New York: McGraw-Hill, 2d ed., 1950), sec. 3.4, p. 39.
(*69*) "Warren Report," p. 79.
(*70*) Outside contact report with Thomas Alyea, Sept. 18, 1978, House Select Committee on Assassinations (J. F. K. Document No. 001769).
(*71*) Staff report and photographs, Nov. 14, 1977, House Select Committee on Assassinations (J. F. K. Document No. 003295).
(*72*) CE 139, 16 Warren Commission Hearings, 512; CE 1303–04, 22 Warren Commission Hearings, 480; CE 737, 17 Warren Commission Hearings, 511; testimony of Lyndal L. Shaneyfelt, April 23, 1964, 4 Warren Commission Hearings, 280–281; CE 747, 17 Warren Commission Hearings, 522.
(*73*) "Warren Report," p. 129.
(*74*) See ref. 67.
(*75*) Manual of Photogrammetry, vols. I and II (3d ed., 1966), American Society of Photogrammetry.
(*76*) Outside contact report with C. S. McCamy, May 23, 1978 (J. F. K. Document No. 008621).
(*77*) See ref. 67.
(*78*) "Warren Report," p. 127.
(*79*) See ref. 2.
(*80*) See refs. 3 and 4.
(*81*) See paras. 33–34 and 39–41 of this report of the Photographic Evidence Panel.
(*82*) "Warren Report," pp. 18–19.
(*83*) Testimony of Tom C. Dillard, Apr. 1, 1964, 6 Warren Commission Hearings, 164.
(*84*) Staff interview of James W. Powell, Jan. 12, 1978, House Select Committee on Assassinations (J. F. K. Document No. 004644).
(*85*) FBI interview of Robert J. E. Hughes, Nov. 30, 1963; CE 2591, 25 Warren Commission Hearings, 873.
(*86*) See ref. 83, Dillard testimony.
(*87*) See ref. 84, Powell interview.
(*88*) Letter from Dr. P. G. Roetling to the House Select Committee on Assassinations, July 31, 1978 (J.F.K. Document No. 010433).
(*89*) "Photographic Image Production and Analysis," a report prepared by the Rochester Institute of Technology (RIT) for the House Select Committee on Assassinations' Photographic Evidence Panel, July 16, 1978, pp. 33–34 (J.F.K. Document No. 014322).
(*90*) Letter from Stanford Research Institute International to the House Select Committee on Assassinations, Autoradiographic Intensification of Photographic Evidence, July 14, 1978, P.O. 65466 (J.F.K. Document No. 010025).
(*91*) Reports prepared for the House Select Committee on Assassinations' Photographic Evidence Panel: (1) University of Southern California Image Processing Institute (USCIPI), "Computer Processing of Kennedy Assassination Photographic Evidence," July 1978, pp. 7–10 (J.F.K. Document No. 009716); (2) The Aerospace Corp., Digital Image Processing Analysis of Photographic Evidence Relating to the John F. Kennedy Assassination, December 1, 1978, pp. 19–21 (J.F.K. Document No. 013712).
(*92*) See ref. 91, Aerospace report, pp. 22–32.
(*93*) Letter from the Aerospace Corp. to the House Select Committee on Assassinations, December 11, 1978 (J.F.K. Document No. 014205); letter from the House Select Committee on Assassinations to the U.S. Attorney General, January 8, 1979 (J.F.K. Document No. 014710).
(*94*) Statement of Special Agent Paul E. Landis, Jr., November 30, 1963, CE 1024, 18 Warren Commission Hearings, 753; see ref. 2, Thompson, "Six Seconds in Dallas," pp. 23–26.
(*95*) See for example, Model and Groden, ref. 2; and Sprague, ref. 2.

(*96*) Testimony of Phillip L. Willis, July 22, 1964, 7 Warren Commission Hearings, 493.
(*97*) FBI Interview of M. A. Moorman, November 23, 1963, (CE 1426), 22 Warren Commission Hearings, 838–39.
(*98*) Testimony of Leo J. Gauthier, May 6, 1964, 5 Warren Commission Hearings, 137.
(*99*) Ibid.; see ref. 96, Willis testimony, pp. 493–94.
(*100*) See ref. 91, USCIPI report, part II, the Black Dog Debate (J.F.K. Document No. 009716).
(*101*) See ref. 4, Andrews and Hunt, pp. 126–46.
(*102*) See ref. 91, Aerospace report and USCIPI report.
(*103*) Ibid.
(*104*) See for example, Model and Groden, ref. 2; and Thompson, ref. 91.
(*105*) See ref. 36, Bolt Beranek & Newman.
(*106*) See ref. 89, RIT report, p. 35.
(*107*) See ref. 91, Aerospace report.
(*108*) See ref. 2, Model and Groden.
(*109*) See ref. 91, Aerospace report; letter from Los Alamos Scientific Laboratory to the House Select Committee on Assassinations, August 14, 1978 (J.F.K. Document No. 010855).
(*110*) See ref. 4, Andrews and Hunt, pp. 126–146.
(*111*) See ref. 91, Aerospace report.
(*112*) See ref. 4, Andrews and Hunt, pp. 193–98; see ref. 109, letter from Los Alamos Scientific Laboratory.
(*113*) W. K. Pratt, *Digital Image Processing* (New York: Wiley & Sons, 1978), p. 641.
(*114*) *Nix Film Analysis*, Itek Corp., Lexington, Mass. (1967).
(*115*) *Ibid.*
(*116*) See ref. 2, Model and Groden.
(*117*) Letter and report from the University of California Los Alamos Scientific Laboratory to the House Select Committee on Assassinations, June 27, 1978 (J.F.K. Document No. 009636).
(*118*) See ref. 43, USGS report.
(*119*) See ref. 117, letter and report from the University of California Los Alamos Scientific Laboratory.
(*120*) Sears and Zemansky, *University Physics*, Addison Wesley (1957).
(*121*) Letter from the University of California Los Alamos Scientific Laboratory to B. Hunt August 7, 1978, on the "Man-in-Bushes questions" (J.F.K. Document No. 014487).
(*122*) See ref. 113.
(*123*) *Ibid.*
(*124*) See ref. 121, letter from the University of California Los Alamos Scientific Laboratory.
(*125*) Testimony of R. S. Stovall, April 3, 1964, 7 Warren Commission hearings, 193.
(*126*) Testimony of Guy F. Rose, April 8, 1964, 7 Warren Commission hearings, 231.
(*127*) Testimony of Lyndal L. Shaneyfelt, September 1, 1963, 15 Warren Commission hearings, 693; but see also Rose testimony, ref. 126 (Dallas police found two negatives that showed Oswald holding a rifle in his hand, wearing a pistol at his hip); executive session testimony of R. L. Studebaker, October 5, 1978, House Select Committee on Assassinations (J.F.K. Document No. 014695); executive session testimony of John Grizzaffi, October 5, 1978, House Select Committee on Assassinations (J.F.K. Document No. 014699).
(*128*) Report of Captain Fritz: Interrogation of Lee Harvey Oswald, November 23, 1963, Warren Report, pp. 608–09; see ref. 126, Rose testimony.
(*129*) FBI interview of Mrs. Lee Harvey Oswald, December 3, 1963 (CE 1401), 22 Warren Commission hearings, 751.
(*130*) *Ibid.*
(*131*) Testimony of Mrs. Lee Harvey Oswald, February 3, 1964, 1 Warren Commission hearing, 15.
(*132*) FBI interview of Mrs. Lee Harvey Oswald, Feb. 22, 1964 (CE 1404), 22 Warren Commission hearings, 785.
(*133*) Testimony of W. J. Waldman, May 20, 1964, 7 Warren Commission hearings, 365; Warren report, p. 128.
(*134*) See ref. 127, Shaneyfelt testimony, p. 692.
(*135*) See ref 131, Mrs. Oswald testimony, pp. 15–16, 118.

(*136*) Warren report, p. 128.
(*137*) Testimony of Mrs. Lee Harvey Oswald, June 11, 1964, 5 Warren Commission hearings, 405.
(*138*) Testimony of Lyndal L. Shaneyfelt, Apr. 23, 1964, 4 Warren Commission hearings, 284.
(*139*) Warren report, pp. 127, 592–597; see ref. 138, Shaneyfelt testimony, pp. 288–89.
(*140*) Ibid.
(*141*) See Shaneyfelt exhibits 2–18, 21 Warren Commission hearings, 443.
(*142*) See ref. 138, Shaneyfelt testimony, pp. 290–94.
(*143*) Ibid., pp. 281–82.
(*144*) See ref. 2, Lane pp. 356–362; Model anl Groden, pp. 190–92; Meagher, pp. 200–09; Shaw, pp. 47–50; testimony of Jack D. White, Sept. 14, 1978, 9 House Select Committee on Assassinations—J.F.K. hearings, 322–40.
(*145*) Syndicast Services videotape interview with Malcolm Thompson, as seen in BBC–TV film, *The Assassination of President Kennedy * * * What Do We Know Now That We Didn't Know Then*, Mar. 7, 1978 (J.F.K. Document No. 006039).
(*146*) Ibid.
(*147*) See ref. 129.
(*148*) See ref. 131, Mrs. Oswald testimony, p. 16.
(*149*) Testimony of Mrs. Marguerite Oswald, Feb. 10, 1964, I Warren Commission hearings, 146–48.
(*150*) Staff summary of interview with Mrs. G. Dees, Jan. 5, 1977, House Select Committee on Assassinations (J.F.K. Document 004030).
(*151*) Receipt of subpenaed photograph, Apr. 5, 1977 (J.F.K. Document No. 001145).
(*152*) Copy of manuscript, Apr. 7, 1977 (J.F.K. Document No. 007503).
(*153*) Outside contact report with Richard S. Stovall, Apr. 14, 1978 (J.F.K. Document No. 007503).
(*154*) See ref. 125.
(*155*) See ref. 151.
(*156*) See ref. 150.
(*157*) See ref. 153; See ref. 127, Studebaker testimony.
(*158*) See para. 39–41, Scientific Report of the Photographic Evidence Panel.
(*159*) See ref. 127.
(*160*) See ref. 138, Shaneyfelt testimony.
(*161*) H. C. McKay, *Three-Dimensional Photography, Principles of Stereoscopy* (New York: American Photographic Publishing Co., 1953), pp. 1–11.
(*162*) Testimony of C. S. McCamy, Sept. 15, 1978, II, House Select Committee on Assassinations—J.F.K. hearings, 397–98; *Manual of Photogrammetry*, vols. I and II (3d ed., 1966), American Society of Photogrammetry.
(*163*) See ref. 137, Mrs. L. H. Oswald testimony.
(*164*) The FBI conducted a similar series of tests for the Warren Commission; see ref. 138.
(*165*) The Oswald Backyard Photographs, a report to the House Select Committee on Assassinations by Dr. Leslie Stroebel, Mr. Andrew Davidhazy and Dr. Ronald Francis, pars. 447–450, Addendum B to the Scientific Report of the Photographic Evidence Panel, Appendix to the Hearings before the Select Committee on Assassinations, U.S. House of Representatives, 95th Cong., 2d sess. (Washington, D.C.: U.S. Government Printing Office, 1979). volume VI, pars. 445–511 (hereinafter RIT technical report).
(*166*) Ibid., pars. 445–455.
(*167*) Ibid.
(*168*) Ibid.
(*169*) Ibid., pp. 458–459.
(*170*) Deposition of Marina Oswald Porter, Aug. 9, 1978, House Select Committee on Assassinations, pp. 64–65 (J.F.K. Document 013153).
(*171*) See ref. 165, RIT Technical Report, pars. 475–478; ref. 91, USCIPI report, pp. 1–7; ref. 91, the Aerospace Report, pp. 1–9, 13–18.
(*172*) See ref. 171, RIT Technical Report, pars. 466–67.
(*173*) See ref. 91, USCIPI report, pp. 1–7; and the Aerospace Report, pp. 1–9, 13–18.
(*174*) See ref. 2, Model and Groden, p. 192.
(*175*) See ref. 145.

(*176*) See ref. 2, Lane, p. 361; Meagher, p. 208; Model and Groden, pp. 190–91; Shaw, pp. 48–49.

(*177*) See pars. 491–92, Photographic Evidence Panel Report.

(*178*) Cameras are bound by the principles of projective geometry, the basis for the vanishing point concept. (See R. M. Winger, "An Introduction to Projective Geometry"), Dover Publishers, Inc., 1962.)

(*179*) Model and Groden, p. 191.

(*180*) Outside Contact Report with Everett Merritt, June 1, 1978 House Select Committee on Assassinations (J.F.K. Document 009036).

(*181*) See ref. 145.

(*182*) See ref. 91, USCIPI Report, p. 7.

(*183*) See para. 484–85, Photographic Evidence Panel Report.

(*184*) Letter from Fred T. Newcomb to House Select Committee on Assassinations, March 11, 1977 (J. F. K. Document 000913).

(*185*) See ref. 145.

(*186*) See ref. 184; Testimony of Jack D. White, II the House Select Committee on Assossinations—J. F. K. Hearings, 323.

(*187*) See para. 499–508, Photographic Evidence Panel Report.

(*188*) See para. 201–02, Photographic Evidence Panel Report.

(*189*) See ref. 2, Meagher, p. 208; letter and analysis from Jack D. White to the House Select Committee on Assassinations, September 4, 1978, p. 31 (J. F. K. Document 011362).

(*190*) Testimony of Jack D. White, September 14, 1978, II House Select Committee on Assassinations—J. F. K. Hearings, pp. 341–44.

(*191*) Ibid.

(*192*) See ref. 134. Testimony of Joseph P. McNally, September 14, 1978, II House Select Committee on Assassinations—J. F. K. Hearings, 372–76.

(*193*) Staff interview of Malcolm Thomson, September 1, 1978, House Select Committee on Assassinations (J. F. K. Document 011177).

(*194*) Letter from Major J. M. Pickard to House Select Committee on Assassinations, January 4, 1978 (J. F. K. Document 004572).

(*195*) These discrepancies are discussed in Thompson, "Six Seconds in Dallas," ref. 2, pp. 40–58, 99–114, and 196–213; See Warren Report, pp. 59–60 and 85–95.

(*196*) Clark Panel Review of Photographs, X-ray Films, Documents and Other Evidence to the Fatal Wounding of President John F. Kennedy (1968) (J. F. K. Document 002430).

(*197*) See ref. 26, J. F. K. Forensic Pathology Panel Report, House Select Committee on Assassinations—J. F. K. Hearings, para. 151–61.

(*198*) Letter from Dr. G. M. McDonnel to House Select Committee on Assassinations, August 4, 1978 (J. F. K. Document 010585).

(*199*) Ibid.

(*200*) Charles Wilbur, "Medicolegal Investigation of the President John F. Kennedy Murder" (Springfield, Ill.: Charles C. Thomas Publishers, 1978).

(*201*) Humes, J. J., J. T. Boswell, J. H. Ebersole and J. T. Stringer, "Report of Inspection by Naval Medical Staff on November 1, 1966, at National Archives of X-rays and Photographs of Autopsy of President John F. Kennedy," 1966; Carnes, W. H., R. S. Fisher, R. H. Morgan and A. Moritz, "Panel Review of Photographs, X-ray Films, Documents and Other Evidence Pertaining to the Fatal Wounding of President John F. Kennedy on November 22, 1963, in Dallas, Texas," 1968, Washington, D.C.: National Archives.

(*202*) Testimony of James W. Altgens, July 22, 1964, Warren Commission Hearings, 517.

(*203*) Weisberg, Harold, "The Milteer Documents," citation to a report in Weisberg, Harold, Oswald in New Orleans (Cannon Books, 1967), p. 383, in Scott, P., P. Hoch and R. Stetler (eds.), The Assassinations (New York: Vantage Books, 1976).

(*204*) Ibid.; see also ref. 2, Model and Groden, p. 11.

(*205*) This informant was identified as Willie A. Somersett in Dan Christensen, "J. F. K., King: The Dade County Links," Miami Magazine, vol. 27, No. 11, September 1976, p. 25; and Robert Groden, "The J. F. K. Evidence That Nobody Wanted To Reveal," Argosy, vol. 386, No. 1, August 1977, p. 34.

(*206*) FBI interview of unnamed source, Nov. 26, 1963, Commission Document No. 1347, FBI report by Special Agent R. P. Gemberling, July 16, 1964, Bureau No. 62–109060, Field Office File No. 89–43, pp. 120–24.

(*207*) FBI interview of Joseph Adams Milteer Nov. 27, 1963, Commission Document No. 20, FBI report by Special Agents K. A. Williams and D. A. Adams,

December 1, 1963, Bureau No. 62–109060, Field Office File No. AT 105–3193, pp. 24–25.

(*208*) See ref. 203, Weisberg, p. 118.

(*209*) See ref. 2, Groden, p. 33, but see also Secret Service Report, Nov. 27, 1963, S.S. File No. CO–2–33, 915 X–3–11–3363–8 (J. F. K. Document 01439).

(During check of potentially dangerous persons Nov. 22–25, 1963, the FBI agent at Thomasville, Ga., ascertained that Milteer was in Quitman, Ga., at the time of the assassination.)

(*210*) Digital Image Processing Analysis of Photographic Evidence Relating to the John F. Kennedy Assassination, a report prepared for the House Select Committee on Assassinations, by Robert Chiralo, the Aerospace Corporation, Dec. 1, 1978, pp. 43–48 (J. F. K. Document 013712); see also Photographic Image Production and Analysis, prepared for House Select Committee on Assassinations by professors at the Rochester Institute of Technology, July 16, 1978, p. 37 (J. F. K. Document 013712).

(*211*) See ref. 207.

(*212*) Ibid.

(*213*) H. Stoudt, Damon, Albert and Ross McFarland, "Weight, Height and Selected Body Dimensions of Adults, United States, 1960–62," National Center for Health Statistics, Series II, No. 8. U.S. Department of Health, Education, and Welfare, Washington, D.C., June 1965.

(*214*) See ref. 207.

(*215*) C. Snow and J. Williams, "Variation in Pre-Mortem Stature Measurements Compared to Statured Estimates of Skeletal Revezius," Journal of Forensic Sciences (16:455–63), 1971.

(*216*) Outside contact Report (with J. Moriarty, Aug. 8, 1978, House Select Committee on Assassinations (J. F. K. Document 010640).

(*217*) Ibid.

(*218*) Frames of the Bell, Nix, and Muchmore films pan the same spectator area.

(*219*) See ref. 213, Stoudt.

(*220*) Ibid.

(*221*) Ibid.

(*222*) Report to the President by the Committee on CIA Activities Within the United States (1975), p. 255 [hereinafter Rockefeller Commission Report].

(*223*) Ibid.; but see also M. Canfield and A. Weberman, Coup d'Etat in America (New York: The Third Press, 1975), p. 224, alleging the boxcar was originally parked closer to the knoll area and the Texas School Book Depository.

(*224*) See ref. 222, Rockefeller Commission Report, p. 256; see ref. 223, Canfield and Weberman, p. 60.

(*225*) See ref. 222, Rockefeller Commission Report, p. 257.

(*226*) Ibid., pp. 251–52; see ref. 223, Canfield and Weberman, pp. 71–93.

(*227*) See ref. 222, Rockefeller Commission Report, p. 251.

(*228*) Ibid., pp. 256–57.

(*229*) FBI report, Apr. 21, 1975 (J. F. K. Document 014520).

(*230*) Report excerpt prepared for the House Select Committee on Assassinations, July 18, 1978 (J. F. K. Document 010005).

(*231*) See ref. 223, Canfield and Weberman, p. 124.

(*232*) See, e.g., Michael Eddowes, the Oswald File, General Publishing Co., (1977); letter and analysis from Jack D. White to the House Select Committee on Assassinations, Aug. 24, 1978 (J. F. K. Document 011086).

(*233*) L. S. Penrose, "Distance, Size and Shape," Annals of Eugenics (18:337–343), 1953–54; see also Eugene Giles and Hermann K. Bleibtreu, "Cranial Evidence in Archeological Reconstruction: A Trial of Multivariate Techniques for the Southwest," American Anthropologist (63:48–61), 1961; Jacques Gomila, "The Use of Penrose's CH² For an Intra-Population and Inter-Population Analysis to the House Select Committee on Assassinations, Aug. 24, 1978 (J. F. K. Docu-J. S. Weiner and L. Huizinga (eds.), (Oxford: Clarendon Press, 1972), pp. 115–136.

(*234*) See ref. 232, Eddowes, pp. 211–22; letter and analysis from Jack D. White to the House Select Committee on Assassinations, Aug. 24, 1978 (J. F. K. Document 011086).

(*235*) See ref. 232, Eddowes.

(*236*) See ref. 234, White.

(*237*) Ibid.

(*238*) Repeatability of Height Measurements from Photos and Other Sources, a report by the House Select Committee on Assassinations. By W. K. Hartmann, April 1978 (JFK Document 007221).

(*239*) Testimony of Cecil Kirk, Sept. 25, 1978, IV House Select Committee on Assassinations-JFK Hearings, 362–365.

(*240*) Ibid.

(*241*) Ibid.

(*242*) Clyde Snow and Joan Williams, "Variation in Premortem Statural Measurements Compared to Statural Estimates of Skeletal Remains," Journal of Forensic Sciences, October 1971, vol. 16, No. 4, p. 456.

(*243*) Testimony of James W. Altgens, July 22, 1964, 7 Warren Commission Hearings, 517; the photographic evidence panel correlated the Altgens photograph in time to Zapruder frame 255.

(*244*) Warren report, p. 644.

(*245*) Testimony of Billy Nolan Lovelady, Apr. 7, 1964, 6 Warren Commission Hearings, 338–39.

(*246*) Testimony of William H. Shelley, Apr. 7, 1964, 6 Warren Commission Hearings, 328; statement of Buell W. Frazier, Mar. 18, 1964 (CE 1381), 22 Warren Commission Hearings, 647; statement of Sarah D. Stanton, Mar. 18, 1968 (CE 1381), 22 Warren Commission Hearings, 675.

(*247*) See ref. 2, Lane, pp. 354–356; Shaw, pp. 39–42.

(*248*) See ref. 2, Meagher, p. 362.

(*249*) CE 1408, May 24, 1964, New York Herald-Tribune story, 22 Warren Commission Hearings, 793–94; see ref. 2, Model and Groden, pp. 147–49; Meagher, p. 363; and Thompson, pp. 225–27.

(*250*) Ibid.

(*251*) Letter from FBI Director J. Edgar Hoover to J. Lee Rankin, Mar. 9, 1964, Commission document 457.

(*252*) See ref. 2, Thompson, p. 227; outside contact report with Billy Nolan Lovelady, July 5, 1978 House Select Committee on Assassinations (JFK Document 009727).

(*253*) Memorandum from Robert Groden to the House Select Committee on Assassinations, July 21, 1978 (JFK Document 010209).

(*254*) See ref. 210, RIT report, p. 36.

O